PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

MAY 27 1929

THE JUNE SCIENTIFIC MONTHLY

EDITED BY J. MCKEEN CATTELL

REVEALING THE TECHNICAL ASCENT OF MAN IN THE ROSENWALD INDUSTRIAL MUSEUM. DR. WALDEMAR KAEMPFFERT 481

MAN'S INFLUENCE ON INSECTS. PROFESSOR E. O. ESSIG 499

PREHISTORIC FEMALE FIGURINES FROM AMERICA AND THE OLD WORLD. DR. E. B. RENAUD 507

THE DEVELOPMENT OF CULTURE IN RELATION TO POPULATION. DR. WALTER HOUGH 513

HOW SHALL WE MEASURE THE QUANTITY OF LIFE OF AN ORGANISM? PROFESSOR ALBERT P. MATHEWS 518

TALES THAT DEAD MEN TELL. PROFESSOR JOHN HODGDON BRADLEY, JR. 527

INSTINCT AND MAN. DR. MAX SCHOEN 531

THE FUTURE OF SCIENCE. PROFESSOR CHARLES A. ELLWOOD 539

THE SPLEEN. DR. WILLIAM DEP. INLOW 549

THE IMPORTANCE OF NUTRITION IN CHILD HYGIENE. PROFESSOR VICTOR E. LEVINE 554

THE THREATENED SARDINE FISHERIES OF PASSAMAQUODDY BAY. DR. N. J. BERRILL 560

THE PROGRESS OF SCIENCE:
The Thirteenth International Physiological Congress; A New Cultural Center; M. Henri Bergson; A New Method of Measuring Reaction-time 565

INDEX TO VOLUME XXVIII 575

THE SCIENCE PRESS

LANCASTER, PA.—GRAND CENTRAL TERMINAL, N. Y. CITY—GARRISON, N. Y.

Yearly Subscription $5.00 Single Copies 50 cents

NEW BOOKS OF SCIENTIFIC INTEREST

A Short History of Medicine. CHARLES SINGER. 363 pp. Illustrated. $3.00. Oxford University Press.

An historical introduction to the science of medicine for the intelligent layman. The narrative of the earlier time is so condensed that more than half the book is devoted to modern medicine. Stress is placed on the principles of medicine rather than the details of practice.

Devils, Drugs and Doctors. HOWARD W. HAGGARD. 396 pp. 150 illustrations. $5.00. Harper & Brothers.

This narrative tells of the medical practices among savages, surgical operations performed by the Egyptians, the ravages of plagues upon our ancestors, and on the basis that the index of civilization is in the care of the child-bearing woman, the development of obstetrics is traced.

You and the Doctor. JOHN B. HAWES, 2nd. 181 pp. $2.00. Houghton Mifflin Company.

A non-technical book, telling how to prevent disease by an intelligent attention to our physical well-being. In addition to taking up striking symptoms of certain diseases, there are chapters on the basis of medical charges, what medical ethics means and on the relations between patient and doctor.

Racial Hygiene. THURMAN B. RICE. 372 pp. Illustrated. $4.50. Macmillan Company.

The plan of this book is to present to the general reader the fundamentals of genetics in the earlier chapters, in order that the biological foundation may be laid for the sociological application made in the following chapters.

Roentgenology. G. W. C. KAYE. 148 pp. Illustrated. $2.00. Paul B. Hoeber, Inc.

This book gives a concise history of X-rays, the basic physical principles, and some of the modern applications—such as crystal analysis—and protective measures for the operator. Part of the book was presented by the author as the Caldwell Lecture before the American Roentgen Ray Society in 1927.

Old Masterpieces in Surgery. ALFRED BROWN. 253 pp. Illustrated. $8.00. Privately Printed, Omaha, Nebraska.

This is a collection of thoughts and observations engendered by a perusal of some of the works of our forbears in surgery. The material represents the results of studies extending over four years during which time an essay appeared each month in *Surgery, Gynecology and Obstetrics.*

Prometheus, U. S. A. ERNEST GREENWOOD. 213 pp. Illustrated. $2.50. Harper & Brothers.

A history of fire and heat, tracing the discovery of fire and its applications to human uses—how fire came to be utilized for light, heat, cooking and smelting. Of recent times, important problems of the oil industry and of domestic heating are discussed.

An Anthology of Recent Philosophy. DANIEL S. ROBINSON. 662 pp. $4.00. Thomas Y. Crowell Company.

Selections from the writings of the greatest philosophers of the twentieth century, with biographical sketches, analyses and questions for discussion. Primarily designed for use in college courses in philosophy, but also of special interest to those persons who wish to know something of modern philosophy and who have not time to read the literature as it appears.

Modern Psychology. *Normal and Abnormal.* DANIEL B. LEARY. 436 pp. $4.00. J. B. Lippincott Company.

The purpose of this book is to present a scientific basis for the study of the behavior of personality, and to deal with, evaluate and classify personality on the basis of types and degrees of dynamic adjustment to the physical and social environment.

The "Soul" of the Primitive. LUCIEN LÉVY-BRUHL. Translated by Lilian A. Clare. 341 pp. $5.00. Macmillan Company.

The object of this volume is to study the ways in which the people usually termed "primitive" conceive of their own individuality, and to inquire into the notions they possess of their life principle, their soul and their personality.

Emotion as the Basis of Civilization. J. H. DENISON. 542 pp. $5.00. Charles Scribner's Sons.

The aim of this work is to seek the methods that have been used in the past to cultivate the emotions that are of value in social construction. Much space is devoted to a consideration of the emotions essential to the success of our modern democracies.

Our Changing Civilization. JOHN H. RANDALL, JR. 362 pp. $3.00. Frederick A. Stokes Company.

Viewing Western civilization as a complex whole, the author analyzes the present conflicts in our major institutions—science, religion, art, social and moral life. The sub-title of the volume is: "How science and the machine are reconstructing modern life."

The Steppe and the Sown. HAROLD PEAKE and HERBERT J. FLEURE. 157 pp. Illustrated. $2.00. Yale University Press.

The fifth volume of the series entitled "Corridors of Time," in which human progress is traced through its stages of development. This book deals with the cultures of Europe and Asia at the time when the Stone Age was giving way to the age of metal.

The American Year Book. Edited by ALBERT B. HART and WILLIAM M. SCHUYLER. 872 pp. $7.50. American Year Book Corporation.

The annual record of events and progress in the United States. The volume for 1928 contains, in addition to a résumé of the history of the period, an account of the organization and conduct of the business of the country, and of scientific, social and educational progress in America.

(Continued on page ii)

THE SCIENTIFIC MONTHLY

JUNE, 1929

REVEALING THE TECHNICAL ASCENT OF MAN IN THE ROSENWALD INDUSTRIAL MUSEUM

By WALDEMAR KAEMPFFERT

DIRECTOR OF THE ROSENWALD INDUSTRIAL MUSEUM OF CHICAGO

In 1903 Dr. Oskar von Miller invited representatives of German industry to discuss with him the creation in Munich of a museum in which the masterpieces of science and engineering were to be preserved and in which their relation to industry was to be set forth. He had more in mind than a storehouse to which the public would be admitted. Machines were to move. Moreover, the public was to make them move, so far as possible, by pushing the buttons or pulling the levers that controlled the driving energy. There were to be paintings and charts to supply as simply and interestingly as possible facts that could not be discovered by a study of engines which had been cut open to reveal mechanism ordinarily concealed. Dioramas, miniature stages on which apparatus is mounted amid a dramatic setting, were to disclose the circumstances that make the principal industrial processes. Daylight motion-picture projectors were to supplement the exhibits.

Von Miller's proposal was received with acclamation. In a year the now famous Deutsches Museum was actually in existence, housed in the abandoned National Museum. The rulers of the German states from the emperor down, every important manufacturing corporation, every city in Bavaria, contributed either machines or money to make the Deutsches Museum the most conspicuous success of its kind in Europe. In a new building, which was formally opened in 1925 and which bears witness to the devotion and energy of Dr. von Miller, some sixty thousand objects of scientific and technical interest are displayed. Over one million persons pass through the museum in the course of a year, and this in a city which has a population of 680,000. To inspect all of the marvels that have been painstakingly gathered and systematically arranged entails a promenade of about ten miles, and yet most of the million face it with eagerness.

It was not a revolutionary proposal in which Dr. von Miller succeeded in interesting German industry. In the early annual reports of the Deutsches Museum he generously acknowledges his indebtedness for his inspiration to the Conservatoire des Arts et Métiers, founded at the close of the eighteenth century in Paris, and to the Science Museum of South Kensington, which was the outgrowth of the Crystal Palace Exposition of 1851. But the Conservatoire was but an adjunct to the École Centrale, and therefore but a repository for historic models, and the Science Museum, although some of its machines actually moved, had, in 1903, neither well-planned nor well-balanced collections. Certainly no museum director who preceded him had von Miller's magnificent

—*Courtesy of the Field Museum of Natural History*

THE OLD FINE ARTS BUILDING

THE ROSENWALD INDUSTRIAL MUSEUM WILL BE EXACT REPLICA OF THE OLD FINE ARTS BUILDING (HERE SHOWN) LEFT OVER FROM THE WORLD'S COLUMBIAN EXPOSITION OF 1893. THIS REPLICA OF STONE WILL COST $5,000,000 TO BE DEFRAYED BY THE SOUTH PARK COMMISSIONERS AND WILL BE ERECTED IN JACKSON PARK, CHICAGO, ON THE OLD SITE. MR. JULIUS ROSENWALD HAS ENDOWED THE MUSEUM WITH $3,000,000 WHICH SUM IS TO BE SPENT FOR EXHIBITS AND OTHER EQUIPMENT. A COLLECTION WHICH WILL ULTIMATELY BE WORTH AT LEAST $30,000,000 WILL BE HOUSED IN THE STRUCTURE.

conception of a museum which would range over the whole field of science and technology, lay bare the mysteries of industrial processes and present the most recondite technical subjects so fascinatingly that the reciprocations of a locomotive piston in its cylinder or the mining of coal would be almost as arresting as a play.

Struck by the brilliant success of Dr. von Miller and by the anomaly that, despite its achievements in science, engineering and industry, the United States had nothing that corresponded with the Deutsches Museum, Mr. Julius Rosenwald decided to establish in Chicago not merely an imitation but an institution which would utilize the experience of Europe as a foundation and which would develop the technique of Munich. He laid his plan before the Commercial Club of Chicago, which is composed of representative business men, and in 1926 expressed his willingness to endow an American technical museum with the sum of $3,000,000 to be spent for equipment alone. The club formed a board of trustees[1] and undertook the task of creating the museum and administering the fund. The city likewise responded and generously. In Jackson Park stood the old Fine Arts building, a disintegrating reminder of the World's Columbian Exposition of 1893 and an architectural masterpiece which, in the opinion of the late Augustus Saint Gaudens, "is the finest thing done since the Parthenon." The South Park commissioners were authorized to issue bonds to the value of $5,000,000 for the purpose of reproducing the structure in permanent form so that it could safely exhibit scientific and technical collections, which, if the Deutsches Museum is a criterion, will ultimately be so large that they will be worth at least $30,000,000. Thus was born the institution provisionally called the Rosenwald Industrial Museum. By the summer of 1929 the work of erecting a replica will begin. By 1933 it is hoped that the museum will not only be completed but actually open to the public, although there is no intention of filling by that time halls as vast as those of the Deutsches Museum.

The magnificent scientific and industrial museums of Europe, pioneers in a new form of visual education, content themselves with explaining technical principles and processes with admirable simplicity. Is this enough? At the outset the sponsors of the Rosenwald Industrial Museum reached the conclusion that the time had come when a forward step must be taken and that Chicago, because of its geographical situation and its industrial importance, seemed called upon to become an American pioneer in this field of visual education. On the experience acquired by Munich, Paris and London an institution is to be reared that has no exact counterpart anywhere, despite the outward similarity that it will bear to the technical museums of Europe. And this forward step is to be taken by amplifying foreign practice—by presenting not only machines in motion but also by illuminating the social phases and cultural aspects of science and technology.

[1] W. R. Abbott, president of the Illinois Bell Telephone Co.; Sewell L. Avery, president of the U. S. Gypsum Co.; the late Edward F. Carry, president of the Pullman Co.; Thomas E. Donnelly, president of the R. R. Donnelly Co.; John V. Farwell, director of the National Bank of the Republic; Robert P. Lamont, Secretary of Commerce of the United States; Charles H. Markham, chairman of Illinois Central R. R. Co.; Charles Piez, chairman of the Link Belt Co.; Theodore W. Robinson, vice-president of Illinois Steel Co.; Julius Rosenwald, chairman of Sears, Roebuck and Co.; Joseph T. Ryerson, president of Jos. T. Ryerson and Son; Albert A. Sprague, director of Sprague, Warner and Co.; Robert W. Stewart; Harold H. Swift, vice-president of Swift and Co.; Charles H. Thorne, late chairman of the Montgomery Ward Co.; Frank O. Wetmore, chairman of the First National Bank of Chicago; Leo F. Wormser, member of Rosenthal, Hamill and Wormser, Chicago.

MUSEUM FÜR TECHNIK UND GEWERBE, VIENNA, AUSTRIA

MUSEUM FÜR TECHNIK UND GEWERBE, VIENNA, AUSTRIA

As in Munich, historic locomotives will pant in the Rosenwald Industrial Museum as they panted a century ago to show how mechanical transportation on rails began. Later engines, also in motion, will reveal the strides that have been made in hauling heavier and heavier loads and in conveying passengers at higher and higher speeds and with greater comfort than Stephenson dreamed of in 1825. The beams of Newcomen engines will rock and show how cumbrously and inefficiently steam was applied before Watt's time, and the chasm between these obsolete titans and the modern silent, completely encased steam-turbine will be bridged by the inventions of Watt, Hornblower, Corliss and Parsons. Edison's Pearl Street power plant in New York will also be there in miniature—the first of the central stations that ushered in the electrical era of industry. And so will the telegraphs, telephones, radio-signaling devices, telescopes, plows, harvesters and the thousands of inventions without which modern civilization would seem empty. Why we can sit in our homes and listen to the strains of a violin played by a great artist a thousand miles away and wafted on invisible waves that pass mysteriously through mountains and houses as light passes through glass; why chemists have succeeded in synthesizing thousands of perfumes, dyes, flavors, explosives and healing drugs from the derivatives of coal-tar, a disgusting ooze once so much of an abomination that it could not be turned into streams lest it poison fish or be buried lest it kill vegetation—all this and more will be explained much after the European example.

Scientific principles and inventions are discovered and made to be utilized. What do they mean in our lives? It is this question that the Rosenwald Industrial Museum intends to answer as well as to explain science and industry technologically. In Munich a student learns more sound engineering in half a day by watching an engine turn a crankshaft than he can learn in a week by studying the diagrams and descriptions in a text-book. In Chicago he will supplement technical knowledge similarly acquired by learning from three-dimensional models, pictures and films what effect the engine had on the society of which he is a member.

It was Herbert Spencer who first pointed out that instruments and machines are but extensions of the human organs, and it is thus that many of them must be interpreted if their social significance is to be fully grasped. What is a steam-actuated, organ-peel bucket but a huge steel hand which clutches five tons of ore or coal instead of five ounces? What is any gantry crane but a gigantic system of steel muscles controlled by the living brain and the hand of an intelligent workman whose chief exertion is the closing and opening of a switch? Telescopes and microscopes—what are they but amplifications of the human eye? The historian Fairgreave has driven home the social meaning of these extensions of the human body by strikingly contrasting the society of ancient Greece with that of New York and of Chicago or London in terms of manpower. In the time of Pericles a Greek freeman commanded the services of five helots or slaves—the equivalent of about half a horse-power; and the best grain mill in the heyday of Athens produced roughly the equivalent of five barrels of flour a day. Over ten years ago Gilbert and Pogue estimated that the average free-born American of our time has at least thirty slaves at his beck and call in the form of machines, an estimate which has since been doubled by others. A good modern grain mill produces at least 20,000 barrels of flour a day. In a steel mill or an automobile factory a single worker may control ten thousand horse-power. Brains have become more important than muscles. Suppose that

—*Courtesy of the Science Museum*

SCIENCE MUSEUM, SOUTH KENSINGTON, LONDON

we were to sweep away these automata and that we were compelled to produce the goods we consume at prevailing costs by harnessing human energy to swing hammers that weigh tons and to lift ladles that contain small lakes of liquid steel. The United States alone would have to support a population at least sixty times greater than it is, if the average American is to maintain himself in what he has come to consider economic decency and comfort. Thus we are enabled to picture in imagination the social and economic consequences that have attended the introduction and evolution of industrial processes. And thus it is that the Rosenwald Industrial Museum will undertake to interpret the machine.

The populations, mostly slaves, that western countries would have to sustain to produce with man-power alone the goods now consumed raises a question. How would these human swarms be fed? And that in turn makes us consider how the civilized world feeds itself to-day, numerically stronger now than it ever was. The truth is that even the nations of this machine age would starve were it not for the aid of science and engineering—starve for lack of chemical fertilizers and mechanical plows, sowers and reapers, for lack of steamships and railway trains, for lack of methods whereby foods may be preserved so that the plenty of fat years may be enjoyed in the lean. We see, then, what a dominant rôle agriculture, the packing industry and the preservation of foods by refrigeration and canning processes, industries of which Chicago may be regarded as the capital, must play in the Rosenwald Industrial Museum. So the thousands of visitors who will pass in and out of the museum in the course of a month will acquire a vivid sense of what engineering and natural resources mean in their own lives. The harvester

and reaper, locomotives and steamships will cease to be merely ingenious combinations of machine elements and become saviors of the human race.

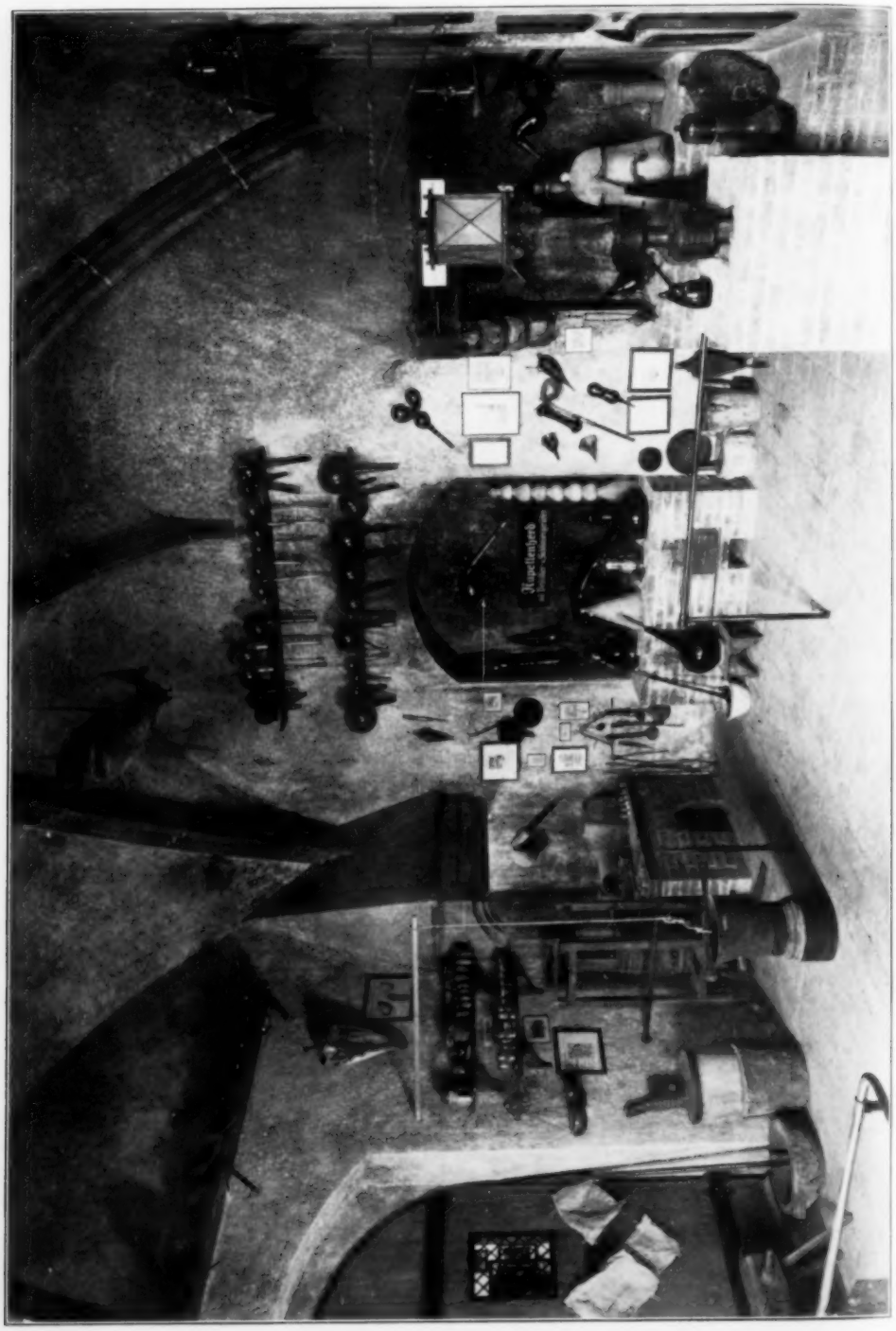
Intimately connected with this feeding of the world is the problem of keeping it in health—of staving off disease. The introduction of the steam-engine gave us the factory and mass production, and the steam-engine in turn made it necessary to huddle masses of humanity in industrial centers. Social problems were presented which could be solved only by science. Without its aid tuberculosis and typhoid fever would make it impossible to house workers decently or to provide them with the clean, well-lighted factories and offices in which they now work. The bacteriologist and the sanitary engineer are doctors of civilization. In that section of the Rosenwald Industrial Museum which will be devoted to the evolution of the industrial city, water-pipes and drainage systems, stepped-back skyscrapers and smoke-consumers will therefore appear not alone as interesting applications of science but as the means whereby an industrial society is enabled to work and clothe and feed itself without committing suicide.

Similarly, chemistry will be presented both as a technical aid and as a social and economic force. We are now passing almost unconsciously through a chemical revolution. In the Rosenwald Industrial Museum we shall see the chemist not only mimicking nature in the factory but tearing matter apart and reassembling its constituent atoms into compounds unknown in nature. It is not enough to trace thousands of drugs, perfumes, flavors, photographic developers and explosives back to coal-tar. We must also connect coal-tar with the industrial rise of modern Germany. Nor can we ignore its effect in strangling the indigo industry of India or the madder-root industry of southern France which latter was responsible for the turkey-red with which the trousers of the French soldiers were once dyed.

As soon as the social implications of science, engineering and industry are thus developed the museum visitor realizes that the nature of technological research is often determined by the conditions under which men live. That necessity is the mother of invention has been thoroughly disproved by Professor Taussig, who finds that most of the great inventors were urged by what McDougall calls the "instinct of contrivance." But how this instinct shall manifest itself is determined by the social and economic pressure of the time. In this respect invention is like art. Jazz and futuristic painting could not have appeared in Lorenzo di Medici's time, nor could the dynamo and radio, simply because the proper cultural and technical heritage were lacking. This means that while Edisons "happen" as do Michelangelos they are stimulated by the artificial environment that their predecessors have created.

The steam-engine, for example, was not wholly the result of a happy technical inspiration. Even those who know something of the history of technology are not all aware that as early as the reign of Queen Elizabeth England's forests had been hewn down, and that Englishmen were more or less dependent on coal as a household and industrial fuel. The coal mines, mere open pits for the most part, were drowned, and the horse-pumps of the time were unable to drain them. By the early eighteenth century the situation was critical. A great invention, some mechanical substitute for the horse, was needed. The economic pressure acted on the brains of dozens, perhaps hundreds, of engineers for at least a century. Two engineers, Newcomen and Savery, proved equal to the task of devising a steam-pump which would surpass the horse as an engine.

Surely it becomes a duty on the part of the Rosenwald Industrial Museum to



SIXTEENTH CENTURY ALCHEMICAL LABORATORY IN THE DEUTSCHES MUSEUM

dramatize the story of this social and economic pressure. But how? The methods are various. Imagine a diorama in which as many as five hundred horses are shown hopelessly struggling with the rising water of a drowned mine. In the neighborhood, smithies and primitive workshops stand idle for lack of fuel, and peasants shiver in their huts. Imagine, too, a suitably worded label which will amplify what little is not self-evident in this staging of England's plight. Perhaps a few statistics may also be required to drive home the full significance of the scene, especially for the university student of economics. We picture a crisis, a situation which can be surmounted only by a highly inventive engineer. We are then ready to study the surmounting means—the Newcomen-Savery engine in which steam is crudely and wastefully condensed within the cylinder itself by means of cold water, so that atmospheric pressure can drive the piston down.

The next step is, of course, the invention of the separate condenser by James Watt, instrument-maker to the University of Glasgow. His technical and social relation to the past is now clear. We see at once how utterly impossible it was for him to have given the world the steam-engine that bears his name without the structure of Newcomen and Savery to build upon. Then follows the most extraordinary social and economic transformation that the world has ever seen—what economists call the "industrial revolution." The museum will depict what it meant to place mechanical energy at the disposal of industry. Coal becomes an even more precious natural resource. Henceforth it is energy. Charts will show how coal mines were opened in every civilized country, how great industrial cities sprang up near coal mines, how social problems were created in these industrial centers that only the combined resources of bacteriology, medicine and engineering could solve. The visitor who leaves the museum will come away with the impression that James Watt was something more than a great inventor—that he did more to transform the face of the earth and mold social institutions than Alexander the Great, Julius Caesar and Napoleon Bonaparte, and that history is made in the laboratory and workshop as well as on the battlefield.

When we thus consider the social implications of the engineer's work the real meaning of this dawning electrical age becomes apparent. To be sure, the rise of electricity from Thales to Thomas A. Edison must be traced technically if for no other reason than to show that for centuries electricity was of no social and economic importance. There will probably be a reproduction of the famous laboratory in which Sir Humphry Davy and Michael Faraday conducted their classic researches, and the visitor will perhaps imagine that he is himself Faraday when he performs the very experiments that enabled the greatest of experimenters to lay the foundations of modern electrical engineering. A new social world will be revealed to him when the visitor sees what Morse, Bell, Edison, Siemens and Marconi accomplished with discoveries that seemed to have but a purely scientific worth at the time that they were made. Energy is no longer localized by coal. It is shot hither and thither along wires and sent rippling through empty space itself. The visitor will understand the significance of the transition period through which we are now passing, a period in which electrical energy generated by twenty and even fifty central stations located in a dozen states is pooled to form a great invisible reservoir which may be tapped at will, so that an excess in one city may make good a deficiency in another. Three-dimensional models, some of which will move incessantly, will make it clear to him that our industrial centers are

SIXTEENTH CENTURY ALCHEMICAL LABORATORY IN THE DEUTSCHES MUSEUM

DISTILLING APPARATUS IN THE DEUTSCHES MUSEUM

already beginning to disintegrate, that factories are being slowly transferred from overcrowded cities to regions where land is cheap, labor abundant and electrical energy available. He will become aware of the fact that he is participating in an electrical revolution and that, like James Watt, the electrical engineer is molding society and rearranging the economic and social structure.

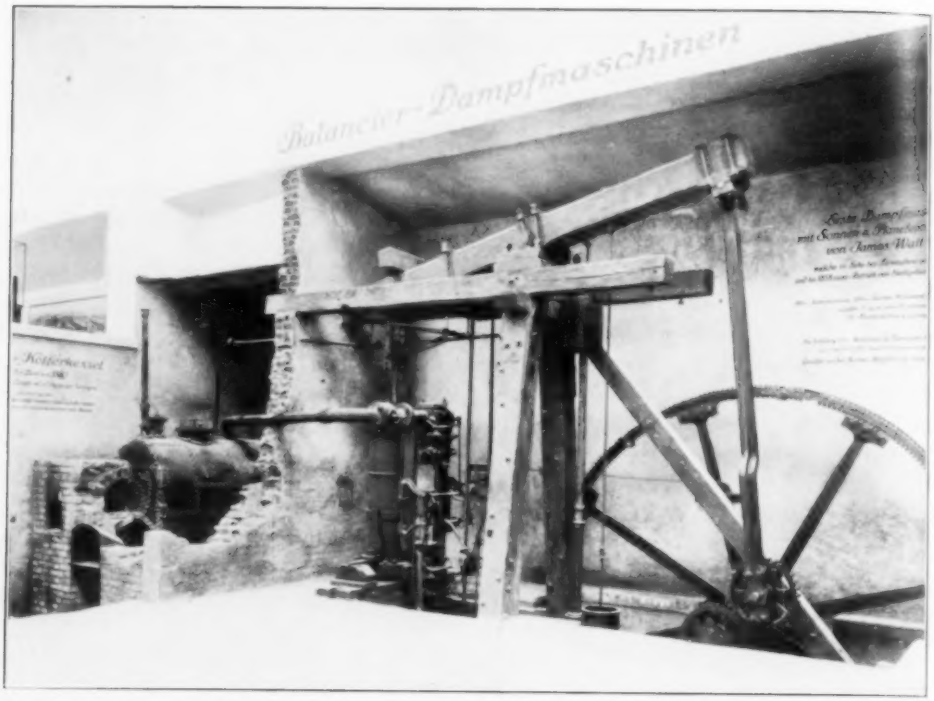
One after another the great inventions and discoveries will thus be taken up, first to be explained technically and then to be socially and economically integrated with their time. Hence we must not be content with a working model of the first Otis elevator. We must also show how that elevator made possible the Chicago and New York that we know, cities with structures towering to heights that still seem incredible to many a European. Perhaps we shall show the vast area that Chicago would have to cover if its office buildings were but five stories high. Certainly the museum must

present the social problems that the skyscraper, the direct result of the elevator, has created—present, for example, the spectacle of fifteen and even twenty thousand people, the population of a small town, discharged from a single building upon the street at the end of a working day, and then connect these hordes with elevated railways, subways, trolley-cars and omnibuses. In other words, the elevator, the tall office building, hotel and apartment house, subways and street-railways are socially related to one another, and this organic relationship must be brought out by models, paintings, motion pictures and dioramas.

Similarly the cotton-gin becomes more than the simple mechanism that it is. We shall see it in the Rosenwald Industrial Museum changing the entire primitive character of the south, creating a demand for labor which was met by the importation of slaves, and thus confronting us with a social problem, in this case a racial problem, which is not yet completely solved.

One of the most interesting halls will be that devoted to what may be called the news of science and technology. If a few centuries hence one of our descendants were called upon to write a history of the United States on the basis of the news published in the American papers of our time the picture that he would form of life in the early twentieth century would surely be distorted. Only the advertisements would save him from concluding that it was almost impossible to venture abroad without being robbed, assaulted or murdered, that public officials were usually corrupt and that our private lives were scandalous. Since we gossip in print chiefly about death and destruction the great technical accomplishments of our scientists, the important news of the day, receive short shrift. The Rosenwald Industrial Museum has no intention of competing with the press, but its officers conceive it to be one of their principal tasks to show how the pioneers of science, engineering and industry are pushing on and establishing new frontiers.

Pure speculation will play no part in the Rosenwald Industrial Museum, and yet the people of Chicago will catch some glimpses of the technical future as they wander through this new hall devoted to proposals which are practical and which are therefore being seriously considered by states, municipalities and corporations. Of late we have heard much of the English Channel tunnel, for example. Few engineers will deny the feasibility of stepping on a train in London, of traveling under the channel at a speed of sixty miles an hour and alighting in Paris a few hours later. If the Rosenwald Industrial Museum were now in existence there would be a model of that tunnel in the hall devoted to Concepts of the Day, so that Chicago might see how the engineer would make intercourse between France and England easier. Television has become a reality. If that hall were in existence we would display in it a model to make the underlying principle plain and to forecast such social effects as the possibility of producing a play in Chicago and of seeing it and hearing it, with the aid of the loud speaker, in every important city from San Francisco to New York. Or if chemists have discovered (as Berthelot did some twenty years ago) that sugars need not necessarily be squeezed out of canes and roots but that they may be some day commercially synthesized out of familiar gases, the museum will make it possible with the aid of appropriate models exhibited in that hall to understand the nature of the process and to accept it as perhaps the beginning of an era when at least some of our foods will be produced by juggling atoms in a factory rather than by sowing and reaping. In a word, that special hall will be a place where the news of the laboratory will be concretely expressed in models. In



REPLICA OF JAMES WATT'S FIRST STEAM ENGINE IN THE DEUTSCHES MUSEUM

no existing technical museum is such a hall to be found. Science, engineering and industry are not stagnant. In Chicago their vitality and growth will not be ignored.

In a museum which addresses itself to the task of interpreting technology socially the scientist, engineer or inventor will cease to be the familiar "wizard" of the newspapers and will assume a new but less deceptive glamour. His indebtedness to tradition and to the stimulus of his time will become apparent. His genius will never be questioned, but the technical heritage of the race will be correctly appreciated. The public will see for itself that motion pictures, radio broadcasting and television are the products of a long evolution, for the individual steps will be displayed in the museum. As he wanders literally through centuries of human technical and social progress in the Rosenwald Industrial Museum, as he sees how the technical mind has developed such remarkable primitive inventions as the wheel and the sail the visitor will realize how much great scientists, engineers and inventors owe to the sheer momentum of the past. He will also see how one science has borrowed from another, how the metallurgist, for example, has imbibed the principles of chemistry until he has become a chemist himself, how the laws of Newton, once regarded as purely theoretical expressions of relationships of masses to one another, have become the foundation stones of physics and engineering. Hence the labels that will be affixed to the exhibits will place the inventions where they belong in what patent lawyers call "the state of the art." No invention is original in the sense that there was nothing quite like it before or in the sense that its elements are individually new. It is an accretion that may be hundreds and even thousands of years old. One of the principal tasks of the Rosenwald Museum will therefore be that of revealing the tech-

nical heritage, the manner in which one principle is combined with another until at last by patient scientific research and by a supreme effort of synthesis we find the Wright brothers, for example, assembling elements which were in themselves familiar, almost miraculously presenting the world with the first successful, man-carrying flying-machine and thus ushering in a new era in transportation that is bound to have far-reaching social consequences.

This matter of awarding credit where credit is due becomes all the more difficult when we reach our own day. Organized research has become as essential an activity of industry as manufacturing and selling. Technical progress, no longer spasmodic and haphazard, is systematic and even predictable. The lone, heroic inventor probably belongs to the past. His place has been taken by groups of research physicists, chemists and engineers directed by a great leader in an industrial laboratory. Technical achievements are therefore rapidly becoming anonymous because they can not be credited to a single towering genius. Surely it is the task of the Rosenwald Industrial Museum not only to exhibit what has been invented in the past and in the present but also to explain how it was invented and to account for the velocity of the technical progress of our own time.

In any such consideration of the methods of invention and research the part played by the far-seeing business man can not be ignored. He has made research a social and an economic force. The heads of our great industrial corporations must be linked with Boulton, who made Watt what he became, with Cyrus Field, who typifies the daring and the understanding of our technical day better than any other figure, and with

WIND MOTORS IN THE DEUTSCHES MUSEUM

—Courtesy of the Science Museum

SCIENCE MUSEUM; MAIN HALL LOOKING EAST

Gardner Hubbard, who had as much to do with the success of the telephone as Alexander Graham Bell. No one can view the history of invention in the Rosenwald Industrial Museum without discovering that the inventors of old needed keepers and that the business man, so far from being a mere exploiter of technical genius, provided not only the capital but the inspiration and driving force without which we would have no railways and aeroplanes, telegraphs and telephones.

Every museum of to-day is primarily an educational institution. Hence museum technique has been profoundly affected by improvements in teaching methods. The successful teacher is usually he whose presentations are most vivid. So we find that both the classroom and the museum are livelier and more interesting than they were fifty years ago. The dramatic is introduced not for its own sake but as a means to an educational end, and this is as it should be because it is the primary function of the drama to interpret life. Since the Rosenwald Industrial Museum will explain not only the operative principles of the machines but the relation of the machines to life, it follows that it must count upon dramatic effects to achieve its purpose, but this without becoming theatrical.

Let us take the road, for example. It is not enough to show how the Appian Way was built or what were the technical methods that made the roads of

Macadam and Telford what they were and still are. We must contrast the smooth, hard road of to-day with the knee-deep mud through which our colonial forefathers plowed their way. Read this from Brissot de Warville, a Frenchman who traveled from Philadelphia to Baltimore in 1788:

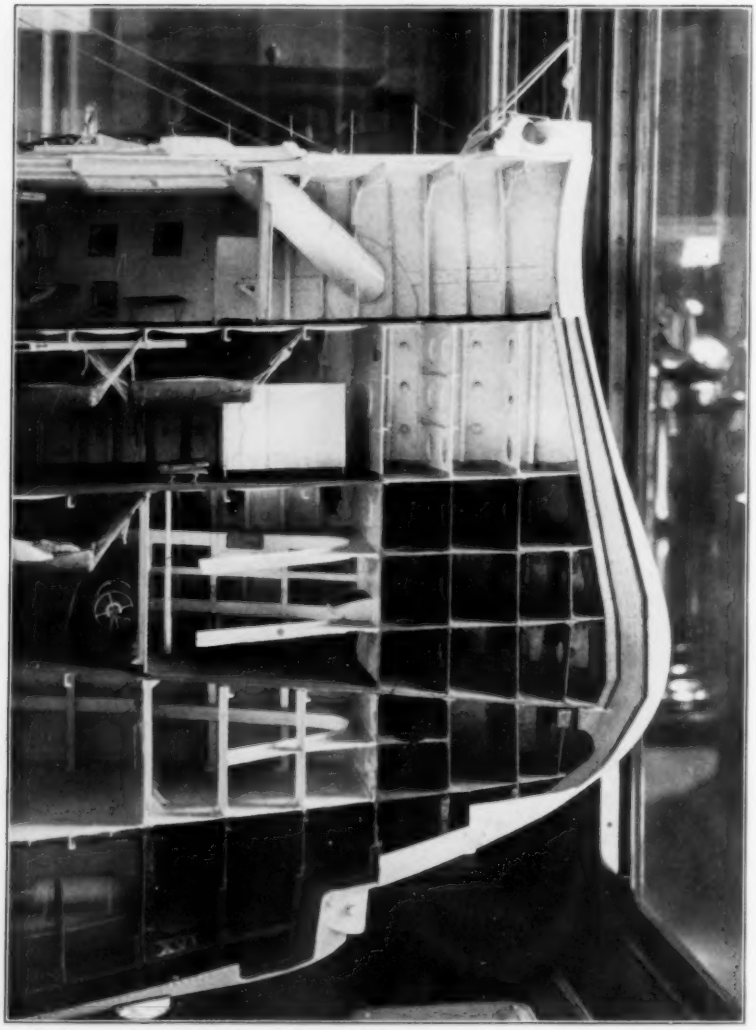
> From thence [Havre de Grace] to Baltimore are reckoned sixty miles. The road in general is frightful; it is over a clay soil, full of deep ruts, always in the midst of forests, frequently obstructed by trees overset by the wind, which obliged us to seek a new passage through the woods. I can not conceive why the stage does not often overset. Both the drivers and their horses discover great skill and dexterity, being accustomed to these roads.

Add to this Lardner's statement that before the days of good roads and railways the charge for carriage by wagon between London and Leeds was at the rate of about $63.31 a ton, or twenty-seven cents per ton-mile, and we have material enough for an exhibit which will show how manufacturing was hampered and why such heavy materials as coal "could be available for commerce only where their position favored transport by sea." It is easy enough to imagine a diorama which will explain the difficulties of trading two hundred years ago and prepare the visitor for the railway and the enormous part that it played in the national and international growth of manufactures.

When it comes to tracing the evolution of railway rolling stock the museum will be faced with a difficulty. The policy of exhibiting full-sized machines has proved to be the best in Europe. Yet, despite its 400,000 square feet of floor space, the Rosenwald Industrial Museum is not large enough to contain every important railway vehicle from the first coach which was hauled on the Stockton and Darlington Railroad over a hun-

—Courtesy of Deutsches Museum

DIORAMA OF THE ISAR HYDROELECTRIC PLANT



BOW OF THE BATTLESHIP "RHEINLAND" IN THE DEUTSCHES MUSEUM

dred years ago and which bears all the evidence of its horse ancestry, to the modern, steel Pullman sleeper. So the Rosenwald Industrial Museum must telescope time and space. A car will be constructed which will be divided into periods. In the first compartment you may seat yourself, and experience all the sensations of bumping over the poorly ballasted and none-too-well-laid rail of the forties; for that compartment will be mechanically shaken to impart the realities of a railway journey in the days of our grandfathers. As you look out of the window you see the landscape of the time—a realistic painting, ingeniously illuminated, traveling endlessly on rollers. The last compartment will be that of a modern Pullman sleeper. Its motion will be hardly perceptible, and from the windows the painted skyscrapers of Chicago will be visible.

It is likewise impossible to trace the development of pavements, water supply and sewage disposal with full-sized reproductions of streets. And so in the

Rosenwald Industrial Museum there will be a street which will be easily ninety feet long and which will be divided into periods of time. In two minutes the visitor will walk from the seventeenth century to the twentieth. He will see a gentleman of Elizabethan London carried in a chair through the mud with link-boys to light his way home; he will note the absence of an adequate water-supply and drainage system. As he steps into the next division it will strike him that oil lamps illuminate the darkness and that footway and carriageway have improved. And so, as he walks on, he will be impressed with the change wrought by the introduction of gas and electricity, of water and sewer mains and of better houses, all bearing an obvious technical relation to the improved street. Finally he enters a few feet of Michigan Avenue of to-day, with shop windows and streets brilliantly illuminated, with the hard, smooth asphalt beneath his feet, and a roadway honeycombed with conduits for cables that deliver energy or convey messages.

The temperament and mental needs of America are different from those of Europe. Accordingly, the Rosenwald Industrial Museum must evolve its own methods in an effort to keep pace with the rapid transitions of America. The motion picture, for example, still plays a minor rôle in Europe, partly for lack of funds and partly for lack of a sturdy and faultless daylight projector. In the Rosenwald Industrial Museum scores of motion-picture machines will be found, operated for the most part by push-buttons. It will be their function to clarify the obscurities of radio and X-rays, the Einstein theory of relativity and the wheeling of the planets. With their aid the public will be photographically transported into steel mills and factories to learn how the principles elucidated by moving models have been industrially applied. Some of the films will talk in sound-proof booths and thus relieve attendants of much lecturing.

The wax manikin is still inevitable. Yet in Chicago the experiment will be made, at first on a small scale because of the expense involved, of substituting here and there living flesh and blood for wax. If we are to show how life has been affected it should be with the aid of life itself. In an auditorium in which distinguished sociologists, economists, scientists and engineers will deliver popular lectures an opportunity will be presented to test the possibilities of this innovation in museum technique. If a distinguished anthropologist lectures on primitive inventions he will be assisted, if need be, by skilled and suitably costumed pantomimists who, amid proper surroundings, will live over again the precarious lives led by huntsmen forty thousand years ago or give us a vivid glimpse of what existence must have been among the Swiss pile-dwellers. So, too, the possibilities of some new invention, such as television, may be disclosed with an effectiveness that can not be attained even by the motion picture.

Pure science being the basis of modern industry, it follows that its achievements from remote antiquity to our own time must be presented simply and arrestingly. Again the visitor will be asked to consider more than a collection of historic apparatus and to teach himself the principles of physics and chemistry. He will learn what hitherto he could learn only out of books, what is not taught in any European technical museum and yet what is psychologically of the utmost importance in understanding why more technical improvements are now made in a decade than were once made in centuries—learn how we came to assume the objective attitude toward nature. The "industrial revolution" was brought about not only by wise patent laws and the steam engine but by the impersonal investigations of the scientist. That the student of natural science refuses to permit his personal beliefs and opinions to sway the course of his experimenting, and that he should

study a precipitate in a test-tube, a flash of lightning or an electromagnetic storm on the sun with complete detachment is something new—something scarcely more than two centuries old. He will learn, too, that Einstein's startling achievement is primarily due to a still further separation of the human personality from the thing or the event that it studies and that what we call "common sense" changes as science advances. So the cultural value of scientific research will be explained to the end that its true relation to modern industry will become more apparent.

The need of an educational institution such as the Rosenwald Industrial Museum is apparent. Edison and Westinghouse had to acquire their technical knowledge as best they could at a time when there were few, if any, engineering schools in this country. Imagine, then, the mental stimulus that future Edisons and Westinghouses will receive from such an institution as the Rosenwald Industrial Museum. Many a lad is bound to discover that engineering is his true bent. The advanced engineer and the student of industry will likewise profit by an examination of the museum's collections. Science, engineering and industry are so complex in their interrelationship that it is difficult to grasp the causes and significance of their rapid progress. Time was when even those who were not themselves artisans had at least an elementary knowledge of the leading arts and crafts. Horses were shod in a smithy with wide open doors. In this day of the automobile few of the younger generation have ever seen the process of its manufacture. Baking and laundering are now the business of great companies who have reduced them to chemical control. Houses are of necessity still built in the open, but the window frames and posts are delivered ready made from the mill so that the carpenter does little sawing and planing and is reduced to the status of an assembler of delivered lumber. Nearly all metal is fashioned in distant mills, and as a consequence only engineers know how rails, girders and other structural shapes are produced. The factory and the machine have so far usurped the place of the old-time craftsman that nearly all technical processes, from the making of a tin-whistle to the building of a locomotive, are now carried on with the aid of massive machines which are mysteries because they are rarely seen by the public. The enormous influence that the scientist has had on industry is but vaguely understood. As for the social effects that follow the introduction of new machines and processes, we are aware of them but we do not grasp their deep significance.

The principles of science are not yet the possession of the many even though the age is essentially scientific, and the effect of scientific research, invention and industrial progress is felt rather than understood. When Giotto finished a picture all Florence was jubilant and stopped work to celebrate the completion of a masterpiece which was not only a thing of beauty but which expressed the emotions of an art-loving city, all of which was as it should have been, at a time when art was scarcely less important than religion in the life of Italy. Science has usurped the place of art. It is perhaps asking too much that a city declare a holiday and rejoice at the discovery of the X-rays, but it is not too much to expect an intelligent public to discover what the rays mean to mankind as they find wider and wider application. There is no lack of interest in technology, as the small crowds testify that are fascinated by the stiff but efficient movements of a steam-shovel excavating a huge hole on the site of some future office building. But the people have no opportunity to gratify that interest, no opportunity to survey the technical and social progress of the past and evaluate the status of the present. And it is the primary purpose of the Rosenwald Industrial Museum to create that opportunity.

MAN'S INFLUENCE ON INSECTS

By Professor E. O. ESSIG

UNIVERSITY OF CALIFORNIA

THE dominance of man in this age of the world is evident in many respects. That he now effectually rules the land, air and water can not be denied. That he has at least partly subjugated other living forms may be admitted. In the botanical world he has apparent control of many domesticated plants which furnish food, including cereals, root crops, forage crops, nuts and fruits. He has also been responsible for the total destruction of great forests of temperate regions and thereby has greatly changed the botanical features of huge expanses, which show no immediate promises of returning to their original conditions. Likewise he has dominion over such animals as he has been able, through long ages, to domesticate and make subservient to his will. The cattle, sheep, goats, horses, dogs, cats and fowls are none of them likely ever to return to their original state of wild life, although all of them might be capable of doing so if man were entirely eliminated from the earth. Wild animals, not desired for domestication, have been ruthlessly destroyed to furnish food, clothing, ornaments, sport or wealth. Thus have almost completely disappeared the sea-otter, sperm whale, American bison, carrier pigeon, white egret, beaver, antelope and other animals. Only stringent game laws and game refuges are staying the wave of such destruction in all parts of the world. Africa, with its untold wealth of big game, would otherwise be stripped in a single generation by wanton men, who facetiously call themselves "sportsmen."

These, I think, are sufficient examples of man's power over certain types of living organisms. But the story is not yet concluded. In the world of minute organisms what has been done to subjugate the millions of pestiferous bacteria and protozoans, some of which cause man to appear helpless enough at times? And the fungous diseases which continue to cut down his food supply? Has he been able to materially affect any of these in a manner so as to destroy, diminish or even adequately control the least of them? At best he can only temporarily stay their advances. Diseases caused by them have so far never ceased to harass the human race.

Now let us turn to the immediate subject at hand, the insect world. What has man done to stay effectually the claims of these tiny hordes to the supremacy of this age? As one casually surveys the field he is likely to agree with those who are already sounding the warnings against the perils of the ever-present and unrelenting hosts of insect pests. To these perils man has, through the ages, turned a deaf ear and a quizzical, ignorant mind. He has created wonderful inventions to protect himself from his much less offensive and more vulnerable neighbors and has so far completely failed to grasp the significance of the vastly greater importance of these small animals which torment him openly, carry and transmit diseases which have done him to death, which have destroyed his timber and his homes, his crops and domestic animals, and have left him no place on earth to set his foot unmolested! Rather it appears that he has allied himself with these, his worst enemies, in order the more quickly to bring about his own undoing. As

—*Photo by Division of Subtropical Fruits, Univ. California*

LARGE AREAS OF CONTIGUOUS CITRUS GROVES LIKE THE ABOVE HAVE CREATED CONDITIONS MAKING POSSIBLE SUCH DESTRUCTIVE INSECT PESTS AS THE VARIOUS SCALE INSECTS, THRIPS, MITES AND WHITE FLIES. IMMENSE SUMS OF MONEY ARE REQUIRED ANNUALLY TO STAY THEIR RAVAGES.

evidence of this he has failed to rid his own body and home of filthy disease, bearing and transmitting lice, fleas and bedbugs. Throughout the ages these insects have sucked out his life's blood, have tormented him and have rewarded their sustenance with disease and death. The toll of typhus and trench fever in the great war and the common occurrence of all these and many other insects everywhere to-day indicate something of the composure and lack of concern of our race.

But this is only the beginning of the story. Man has not been wise enough to leave his tormentors behind him! He has taken them with him wherever he has traveled; he has sent them to the four corners of the world, and exchanged them with other countries by means of his commerce. Malaria, bubonic plague, anthrax, cholera, dysentery and yellow fever constantly knock at our doors and too often gain admittance. Which of the insects responsible for any of these has been greatly influenced by man? Malaria mosquitoes are suggestive and yet can any one hopefully argue that they are actually fewer in numbers now than they were a thousand years ago? Does it not appear that they have increased through wider distribution and perhaps more special and favorable conditions brought about by man? That certain small areas have been made inhabitable through the efforts of our race, as for instance the Canal Zone, is no real indication of the world distribution and abundance of the particular insects involved.

Man's fight for equatorial South America and Africa has been due chiefly to the barriers raised by insects. That they can be conquered without gaining a wider distribution throughout the world is contrary to past experience. Everywhere the balance is on the side of the insect.

To the development of economic entomology in relation to agriculture we may look to find some glorious examples of vanquished insects. A note of encouragement may be sounded in the denuding of great forest areas and the destruction thereby of many serious forest pests. In this regard China has exchanged forest insects for famine-producing grasshoppers. In America the reclamation of the swamps and prairies has somewhat disturbed mosquitoes and grasshoppers, but the planting of huge continuous fields of wheat, corn, cotton, potatoes and orchards has created such pests as the chinch bug, Hessian fly, corn earworm, corn borer, cotton bollworm, Colorado potato bettle, San José scale and other insects unknown to man a few generations ago!

The cultivation and irrigation of the Great Basin has had a marked influence on stopping the migrations of locusts into Kansas and Nebraska—now they stay home! In many parts alfalfa has replaced buffalo pastures and the alfalfa weevil, an insect of little importance in southern Europe, becomes a Napoleon in this once semi-arid region.

In California we have almost within one generation built up a new and complete agriculture. Did we consider the

TO REPLACE THE NATIVE VEGETATION MAN HAS OFTEN SUBSTITUTED WELL-CARED-FOR ORCHARDS, WHICH INVARIABLY ATTRACT INSECTS FROM SURROUNDING AREAS. IN SUCH CASES THE INSECTS HAVE GREATLY BENEFITED BY THE SUBSTITUTION AND MANY NATIVE OR IMMIGRANT SPECIES HAVE THUS BECOME NOTORIOUS PESTS.

HIGH-POWERED SPRAYING MACHINES DISCHARGING POISONED LIQUIDS UNDER GREAT PRESSURE ARE USED TO PRESERVE A PORTION OF THE FRUIT AND NUT CROPS FROM THE RAVAGES OF CODLING MOTH, CURCULIOS, LEAF-ROLLERS, CANKERWORMS AND OTHER INSECTS.

insect problem in connection with our personal comfort and health? Did we consider our domestic animals and our food supply? Not at all! The day that the Spanish padres arrived in San Diego in 1769 they had with them an adequate number of pests to supply all their needs. The ships which immediately followed brought those lacking. In the earliest days our state became famous for its flies, fleas and weevils.

The history of some of our chief agricultural pests is interesting and right to the point. The Colorado potato beetle was one of our first insects to become a serious pest of a growing crop. It traveled backwards over man's advance from the Atlantic towards the Pacific. Man's continuous fields of nicely tended potatoes were far more to its advantage than the scrubby buffalo bur of the bleak mountain areas of the west. Since its first appearance in 1865 it has claimed all the cultivated areas of the United States and Canada with the exception of three western states; it invaded Germany in 1887 and reappeared in 1914; it was introduced into France in 1922, and now threatens the rest of Europe. It is a potential danger to potatoes wherever they are grown over the entire world. Its rise from obscurity and its present wide distribution are wholly due to activities of man. No amount of control measures has even suggested a restoration in numbers to its original state in the Rocky Mountains.

From obscurity in the wilds of North America the grape phylloxera, through commerce, was introduced into the vineyards of southern France some time prior to 1863. By 1884 it infested 2,500,000 acres, or half of all the vineyards in France, and in all destroyed at least three fourths of all the vines in that country. It was likewise brought into California, where it was discovered in 1873 and where it also did great damage to the imported European varieties of grapes. At least half of the vineyards

A STRING OF FUMIGATING TENTS IN AN ORANGE ORCHARD IN CALIFORNIA. LARGE AREAS OF EVERGREEN CITRUS TREES ARE IDEAL BREEDING PLACES FOR MANY INTRODUCED PESTS AND IT IS ONLY BY GREAT EXPENSE IN FIGHTING INSECTS THAT THE CITRUS GROWER IS ABLE TO PRODUCE PROFITABLE CROPS.

in France were reconstituted on resistant American rootstocks, while in California the pest was evaded by planting on new lands. Thus the phylloxera, through the direct intervention of man, has had its distribution and scope of food plants very greatly enlarged, while the control measures for its repression have only permitted the grapes to grow in spite of it, rather than eliminated it in any section.

—*Photo by Bean Spray Pump Company*

THE PEA APHIS ANNUALLY DESTROYS FROM TEN TO TWENTY-FIVE PER CENT. OF ALL CANNING AND MARKET PEAS IN THIS COUNTRY. THIS MODERN DUSTING MACHINE IS MAN'S METHOD OF DEALING WITH THE PEST.

The San José scale was introduced into California prior to 1873 by a prominent and wealthy citizen who admired the beauty of the Nipponese flowering fruit trees. In a few years it ravaged every deciduous fruit orchard throughout the United States and Canada, and not stopping here, has since spread to all the temperate regions of the world. It was not a scourge from heaven—it was simply one of the millions of species of insects, each with tremendous possibilities of increase and destruction, placed in the hands of an uninformed people! The codling-moth, the gipsy moth, the brown tail moth, the cottony cushion scale, black scale, red scale and scales of other hues, the cotton boll weevil, pink bollworm, the Japanese beetle, the granary weevil, rice weevil, vegetable weevil, Hessian fly, chinch bug, sugar-cane leafhopper, and, in fact, every serious insect pest has a similar history. Every one of them has had its distribution extended; its food supply enlarged; its activities increased and its numbers greatly multiplied by the intervention of man. I can think of no instance where a notable decrease in distribution or numbers from the original status of any insect has been brought about by the human race! Therefore, it appears that the entomological prophets of our times, who predict a winning contest for the insects, have some basis for their arguments.

INSECTARY CONSTRUCTED BY COOPERATIVE CITRUS FRUIT GROWERS IN SOUTHERN CALIFORNIA. HERE LADYBIRD BEETLES ARE REARED BY THE MILLIONS AND LIBERATED IN THE ORANGE ORCHARDS TO DESTROY THE DESTRUCTIVE MEALYBUGS.

There is still another point in this discussion that should not be overlooked. The insects have so far maintained themselves on this earth much longer than any other living type of higher animals, and very much longer than man. For this reason it may be assumed that insects are capable of withstanding a much greater variety of conditions than the human race. It is also fair to assume that as man acquires age and experience he will be much bet-

ter able to cope with insects and the smaller protozoans and bacteria.

For his very short space of existence man has shown phenomenal adaptability and ingenuity in dealing with his immediate problems of living quarters, food supply, health and general well-being. He has already eliminated many of the larger animals which were serious enemies and impediments to his early ancestors. Lions, tigers, wolves, bears and wild boars are now to be found mostly in zoological gardens and museums. The greatest task now ahead is to do the same with the destructive smaller forms of life. To me this task does not seem at all hopeless. Man's capacity for thinking, his inventive and creative powers appear unlimited. In but a few decades he has awakened somewhat to the real truth of the small enemies which beset his forward progress. He has done one great thing to stay their overwhelming advances—made use of natural checks by setting one form of life against another. In this way he has made vast strides in the reduction of mortality due to contagious diseases. In like manner he has made use of the so-called method of biological control in the subjugation of serious insect pests and as a beginning has already made notable progress in the reduction of certain ones like the cottony cushion scale in California, the sugar-cane leafhopper and other sugar-cane pests in Hawaii, and the woolly apple aphis in many parts of the world. Similar experiments with other insects are now being vigorously pursued in many parts of the world. Unfortunately in this connection he has exterminated or so greatly eliminated many insectivorous birds and mammals as actually to have favored and protected the insects.[1] Listen to any bird man and you wonder how we are able to carry on at all because of the destruction of the feathered tribes!

The question of man's influence upon insects should not be concluded without some word regarding those which he has been able to utilize for economic gain. The most remarkable of these, the silkworm, has become truly domesticated and would probably disappear completely if man's care were entirely withdrawn. The honeybee, though extensively raised for hundreds of years, shows its lack of dependence upon the human race by turning wild wherever it has been successfully introduced. Chinese wax, pela, is definitely reared and tended by the Chinese under conditions which it could not survive without human aid. Cochineal was given a wide distribution as a commercial product and is now being employed in an attempted eradication of introduced cacti in northeastern Australia. The lac insect is utilized as a natural product in India and its preservation from natural enemies is in direct contradiction to the method of biological control. Larger insects have long been utilized for food and I see no reason why, if man is ever hard pressed by these enemies, he can not turn to them as a source of subsistence!

This has been an extremely loose discussion of a most important and difficult problem which faces, not so much our immediate descendants, as it does those in more remote ages. Though we have laid some foundations looking towards the protection of future generations, we have not fulfilled our responsibilities until we have aroused mankind to the full appreciation of the true situation. A world consciousness must somehow be evolved. After this is accomplished in the so-called more enlightened nations it must be instilled into the minds and lives of the most backward and unrefined, for no part of the world is safe so long as

[1] E. H. Strickland. "Can Birds Hold Injurious Insects in Check?" SCIENTIFIC MONTHLY, 26: 48–56 (1928).

these insidious foes are allowed to exist in the remotest corners of the earth! This is a task too enormous to be accomplished by entomologists alone. Much of our time and energy is consumed by the many urgent local problems that require immediate attention. However, it is first and foremost our problem. We should recognize its seriousness, its difficulties and its possibilities for solution. We have made a beginning in the use of quarantine methods for preventing the distribution of insects; the use of toxins and poisons for their immediate destruction; and the method of biological control for their more permanent subjugation. We yet need to reform radically our ideas of home and city sanitation, including personal hygiene and the cleansing or destruction of domestic house animals; better methods in agricultural practices such as more intelligent crop rotation, breeding of resistant crops, crop elimination, planting and harvesting; better methods for storing cured and dried food supplies; and foremost a realization of the importance of a thorough scientific knowledge of all phases of insect life and the intricate part played by insects in all aspects of human welfare!

Ours is not the menial chore so often alluded to as "chasing bugs," but rather the gigantic task of saving the human race!

PREHISTORIC FEMALE FIGURINES FROM AMERICA AND THE OLD WORLD

By Dr. E. B. RENAUD

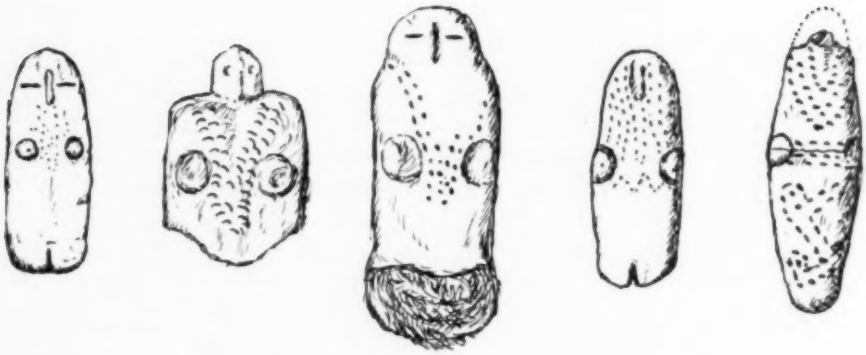
DEPARTMENT OF ANTHROPOLOGY, UNIVERSITY OF DENVER

THE first god was a goddess! This bold paradox seems justified, at least, in the light of archeological finds made both in the Old World and in the American southwest. And we have nothing to the contrary that could militate against the concrete evidence afforded by female statuettes discovered by anthropologists in various parts of the world.

The contributions to the cause of feminism among our ancient deities on this continent come from northeastern Arizona. They are due to two distinguished scientists, friends of mine. The first and larger group of these figurines was dug up in the Cañon del Muerto district in 1924 by Earl H. Morris, now of the Carnegie Institution. On account of the conditions and objects associated with them the explorer ascribed them to an early place in the Post-Basket-Maker Culture, say about 500 B.C., if we accept Dr. A. V. Kidder's suggestion. Two specimens of these little fetishes had found shelter in a corner of the Museum of the University of Colorado, where, with astonishment and interest, I discovered them in 1925 and soon made them known by means of an article in a French review. The rest of the lot attained metropolitan prominence, being housed in the American Museum of Natural History of New York, and were later presented to the scientific public by Earl H. Morris himself in his excellent monograph, "The Beginning of Pottery in the San Juan Area." They are roughly made of a brownish clay and shaped in the form of a small slab, blackened in places as if by frequent handling. They vary in dimensions from fifty-nine to a hundred and twenty-two millimeters in height, and twenty-seven to forty-six millimeters in width and some twelve to eighteen millimeters in thickness. Their main characteristics are essentially the same for all seven, three of which are complete, the others fragmentary. Nose and breasts are usually in high relief, eyes horizontal when visible, a median cleft at the crotch indicating the female organ. In four instances, two of which are very clear, the punctations made in the clay when moist suggest a necklace. The lower part of one figurine is covered with an apron similar to that scanty garment so often found on female skeletons in burials. None have arms or legs.

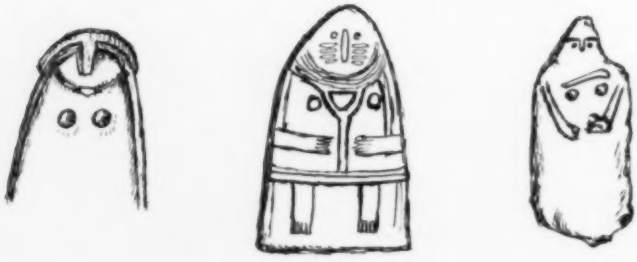
I also described two other similar statuettes now on display at the Museum of the University of Arizona, at Tucson. They were both found by Dean Byron Cummings. One, reddish in color, comes from Monument Valley, northern Arizona, and conforms to the previous type, but its primitive ornamentation is more extensive. The second is made of whitish clay and was found in Sagi Cañon not very far from the other. It is finer both in decoration and shape. Square punctations draw a triple necklace, then three horizontal lines between the breasts are seen, and the lower portion of the figure seems wrapped in a garment adorned with an oblique Z-shaped design. This better made and more artistic figurine may belong to a somewhat later development than the crude representations from Cañon del Muerto, or may simply be a local variation.

These prehistoric female statuettes, the only ones published so far, are the earli-



PREHISTORIC CLAY FIGURINES from ARIZONA.

REALISTIC STATUETTES & BAS-RELIEF. Old Stone Age. Europe



from artificial Cave Menhir-Statue Carved-Stela

FRANCE.

PREHISTORIC FIGURINES FROM NORTH AMERICA AND EUROPE

est human representations known from the American southwest. They are typical of the Post-Basket-Maker period, as none have been reported from Pueblo ruins. They are quite valuable for being so rare and ancient and also very interesting. Can we venture an interpretation? Although rough in presentation they are evidently human and just as clearly feminine and they show traces of frequent use. In view of the psychology of the primitive people who fashioned them, and of others known elsewhere, we may reasonably suppose that we have here fetishes of the feminine principle of fecundity and reproduction as suggested by the prominent breasts and the notch at the base of the figurine. They would represent some sort of a goddess of life, regardless of the belief and ritual possibly connected with them. Found in burials, they may have been placed near the dead as if to give them some kind of post-mortem life. This is not mere speculation and it acquires even a certain degree of probability in the light of our knowledge of Old World archeology, for in Europe, too, the first god was a goddess!

Thus, the most ancient statuettes known date from about the beginning of the Upper Paleolithic period, and are attributed to the Aurignacian people, negroid and possibly Cro-Magnon. They are carved out of stone, bone or ivory, some rudely shaped, others more artistically. The female characters are very much in evidence and even in some cases exaggerated. Leaving out their possible racial features, what seems striking is the fact that they are not representing any particular woman, the face being generally indistinct, but merely womanhood, fertility, reproduction of life. This is a point of resemblance with our rude Indian figurines. Moreover, their being often found in graves suggests their probable association with some belief in post-mortem life.

Leaving the fine realism of the upper stage of the Old Stone Age, we pass a barren aniconic phase and find in later Neolithic times only barbaric representations, sometimes hardly human in form as they are strongly conventionalized. They are scattered over several provinces of prehistoric France. In the Marne district they are carved on the chalky walls of the artificial caves used as burial chambers. The nose is in high relief as well as the eyebrows, while the eyes are sometimes indicated in black; we see a necklace with a single or multiple rows, and often the breasts are clearly visible.[7] We recognize here several characteristics of our Arizona figurines. The Neolithic figures from Champagne have been interpreted as feminine idols, primitive personifications of maternity and akin to the type of the goddess-mother so popular in all the ancient world, according to Déchelette. Their close association here with sepultures shows them in another of their functions, as tutelary divinities of the dead.

On dolmens near Paris rudimentary forms of the same nature have also been recognized but here are even reduced to what seems their essential elements, the breasts and necklace. Evidently this marks the passage from the idol to the symbol, a natural stage of evolution.

In the southern part of France we find carved stelae and the so-called menhir-statues. The general outline is there closer to our American figurines. When the head is still present one sees eyes and nose but no mouth, the breasts sometimes in relief and the clear tracing of a necklace. The rest varies with different specimens. In one section of this area of bas-reliefs, as so far mentioned, there are true statues carved on all sides of a block of stone. A series of the latter group always represents a feminine idol with breasts and necklace, then, in its most characteristic elements, similar to the specimen from the north. We have, therefore, in that period, widely scattered over Neolithic

PREHISTORIC FIGURINES FROM GREECE, ASIA AND CENTRAL AMERICA

France, a more or less realistic or schematic representation of a female deity, a goddess of fecundity and life, associated with the dead. In her essential features and in her probable meaning there is a strong parallelism with our Post-Basket-Maker fetishes.

But these idols in their double aspect of goddess of life and funerary divinity, found in Western Europe in Neolithic and early Bronze times, are members of an extensive family found from Asia Minor to the British Isles. They seem to come from a common Aegean prototype. In the function of tutelary deity of the dead we find her ancestry in a double line of representations belonging to the pre-Mycenaean epoch, one on vases and the other on slabs of marble and schist. Thus, on ceramic specimens from the second city of Hissarlik, or Troy II, we see a symbolic figure with nose and eyebrows, sometimes eyes, never any mouth, but the breasts represented. This type spread from Asia to the Greek archipelago, the Iberian peninsula and Gaul, finally reaching Great Britain, carried by sailors and traders, as commerce was already active along land and sea routes. In these countries stone idols show the same characteristic features and all date from the end of the Neolithic and the beginning of the Bronze Age.

In opposition to the functions of that female divinity in regard to the dead, we may consider now her more cheerful aspect, her personification of fecundity and abundance of love and life. The Orient and a few European countries have honored and worshiped a goddess-mother, symbol of fertility for everything alive—men, animals and plants. Thus we must not be surprised to find her representation multiple and diverse, here rude, there artistic, now realistic and at other times reduced to a few essential characteristics, and even becoming a mere symbol, in places, carved in stone, in others modeled in clay, and even pictured on gold rings. The Chaldeans called her Nana, the Semites Astarte, the Phoenicians Ashtoreth, the Greeks Aphrodite, and the semi-barbarians of the West gave her names which have not reached us.

In the lower strata of Susian and Chaldean ruins were found very crude images of our goddess and later figurines with a wealth of details of body and head-dress, for Nana was nude except for the traditional necklace. In Egypt we have both the realistic statuette and the symbolic, bottle-like outline, in either case with sexual characteristics outstanding as in Mesopotamia. The same can be said for the interesting statuettes from the Trojan district, naked but with necklaces and elaborate head-dresses. In the Greek islands and especially at Cyprus, besides naturalistic representations there is a tendency towards a stiff conventionalization. Not all the figures are standing, some are merely busts with breasts visible and multiple necklaces, others are squatting, as also seen in Cilicia. They lose then much of their artistic appearance. In Crete we have also seated and crouching figurines, made of clay and a variety of stones. Some of the more realistic are adipose and steatopygous like the Aurignacian statuettes and bas-reliefs of southern France. A strong tendency towards a simplified, purely symbolic and at times almost amorphous type is witnessed in many places in the Greek Cyclades, Crete, Asia Minor and the hinterland as far back as the Euphrates and Caucasus. On the European continent, on the contrary, we find many more or less realistic images of the same goddess in erect position such as in Thessaly, along the Danube valley, in Transylvania and southern Russia, generally in the nude, sometimes, as in Cucuteni, the body is covered with parallel curvilinear designs, painting, or tattooing, in other places richly dressed and adorned as at Kličevac, near Belgrade. But in the center of the area, in the Aegaean civilizations, whether in

statuettes of stone or clay or on gold rings, from Mycenae, Knossos or elsewhere, even when the goddess is otherwise dressed, the breasts always remain visible and prominent as the very symbol of the Goddess-Mother. The interesting representations of the Great Goddess on the gold rings of Mycenae, Isopata, a seal from Knossos and other instances, show her with a skirt, but the bust bare, thus recalling the figurine found by Morris in the Muerto Cañon, still with the apron as worn by the women of the time, but the upper part of the body naked.

Thus, under a variety of forms according to countries and times but with the essential characteristics of an attractive female body, we see in the regions bordering on the Mediterranean Sea and even far inland, many statuettes of the goddess of fecundity and life. Humble as they are, our little prehistoric Indian figurines belong to the same divine family and betray the same psychology in primitive men of different continents. What is common to them all is the idea, personification and worship of the life-giving mother, and her essential characteristic is, besides secondary attributes and variety of representations, her nourishing breasts. This is the thought emerging from our rapid comparison. Primitive men from Asia, Europe, Egypt, as well as America have honored and prayed to a benevolent female deity. The first effort of the early Indians of the southwest was the crude modeling of their goddess of fecundity and life, also, maybe, a tutelary divinity of the dead, thus following unknowingly more civilized peoples of the Old World.

But one more point remains to be considered. Some of the less artistic and realistic squatting statuettes from Cyprus and especially Adalia, in Cilicia, Asia Minor, recall to mind some of the archaic American figurines from Central America, such as Spinden has described for Nicaragua, Panama and neighboring countries. One sees in them the same tendency to a broad, flat head, large oval eyes, decorated body in a sitting position. These female images, although the ones were made in western Asia and the others in America, may have had the same general meaning, a product of a common human psychology, and have led to beliefs and practices not so different after all. These archaic figurines probably originated somewhere in Central America, cradle of the Indian civilization, where agriculture started first and pottery later on. From there they spread to South America, following the coasts as far as the Isle of Marajo, Brazil, on the Atlantic side, and Peru on the Pacific, while north they gained Mexico. Now, if one considers that Arizona is located in the marginal zone, far away to the north, having developed agriculture after receiving maize very likely from Mexico somewhere about 1500 to 2000 B. C., having started pottery in the neighborhood of 500 B. C., according to Kidder's suggestions, can we not think that our little female figurines are like the last born of an extensive and varied family or as an echo of the archaic art of Middle America? Even if they are not directly connected with the Central and older American group, more advanced and artistic, it seems fairly probable that they represent much of the same impulse, that they embody a similar belief and personify the same goddess-mother, divinity of reproduction and general fecundity, fertility and abundance, love and life, and may be also a protector spirit of the dead—what we have seen true for the Old World was possibly also the case in archaic America. But, as this feminine cult disappeared in Egypt with the Pharaonic civilization, so it seems to have vanished too from the southwest, at least as revealed to us in the form of Post-Basket-Maker figurines, with the coming of the Pueblo Indians in Arizona.

THE DEVELOPMENT OF CULTURE IN RELATION TO POPULATION

By Dr. WALTER HOUGH
U. S. NATIONAL MUSEUM

How do man's reactions to his near needs differ from what are called instinctive habits, as observed in a bird selecting material and building a nest? Where is the point at which instinct is separated from reactions that are plus instinct? There has come to man gradually and unconsciously something different, higher and capable of important expansion. It is easily believed that man's culture and his physical development went hand in hand. This may be pursued from the postulate stated. It may be conceived that man's advance was promoted by interactions between his consciousness and his inventions, the latter leading to changes in habit which reacted upon his physical make-up. Manifestly nothing definite appears in the earliest periods, in which there must have been transitions, upon which to base even imagination as to physical changes leading to man. When something tangible is reached it appears to burst upon us as a rude culture whose imperishable part consists of an extraordinary amount of a recognizable stone artifact scattered in the drift which has dispersed the evidences of early sites, also the evidence of other culture objects besides stone. We need the Eolithic stage for landmarks of the early period which presents, as stated, embarrassing difficulties of detection. We do not feel sure that the Eolithic has been detected yet, but for that matter who can say where are the evidences that beginning man passed this or that way? Who could find definite fixed traces of the movement of a band of apes in the forest?

Development implies a beginning, or rather merging from one state to another with at first almost imperceptible changes.

The scientifically directed imagination pictures a stone clumsily taken in the hand and thrown aside when the temporary use is over. Again, the stone is carried to a place where a simple need is indicated, thus becoming a known stone for a certain use or for various uses; it comes to show traces of human contact if not traces of use. If laid down and left, it may be selected and picked up again. The stone, having served adequately, may finally be kept for personal use, and be in effect the simple hammerstone so often observed in use among tribes of low culture or perpetuated among more advanced tribes. The hammer in due course may be pitted on the sides for holding, grooved for hafting, and so forth, always remaining a typical simple tool till the age of invention. In use the hammer may chip or spall, giving a cutting edge, and begin the ax series. Instead of the water-worn boulder, a splintered mass of convenient size with cutting edge may be taken up and the development proceed in the order as above.

It is conceived that the simplest and most fundamental tools which required force in their use were the first and most profound modifiers of man in a physical sense. These in use demanded unnatural attitudes, postures, pitting of

one muscle against another and repetitions not demanded from any animal in nature. The crude tools prepared man's hands and body for the use of other tools and implements requiring handling with more skill, hence the development of tools from rude stones into the variety of implements found by archeologists in the successive human layers of strata. It is suggested that the human vertebral curves are due to work with tools. In this way the contour of the spinal column observed in man may have been differentiated from that of the great apes, which is simply curved, to the concavo-convex spinal curves of the human being, which furnish a fulcrum for work with the hands and arms, or generally with the whole musculature of the body. It follows also that the osseous structure would be modified.

The stimulation of invention and the development of material culture is seen to be involved in the increase of population. This may be formulated as follows: With small population environment tends to remain natural; with increasing and large population environment tends to become artificial. That is, the interplay of forces which tend to the production of useful arts and inventions are greater in larger than in smaller aggregates of man. This idea is capable of elucidation and enlargement to any extent.

At the proper place and time and culture stage other inventions occur, as observed in the comparative table of arts in the various archeological stages shown in MacCurdy's "Human Origins." These steps admit of a description of the development of material culture because on the whole there has been progress from the beginning and retrogression takes a negligible position. The study of the development of the arts and industries is based upon and made comparatively easy by the facts of the stratigraphy mentioned. The profound thought here is that there has been progress, be it ever so little in the earlier stages.

The population of the earth has increased till it is greater at present than at any time in the world's history. Against disease, war and all other forms of life termination the population increases. In view of the present increase it may be of interest to speculate on the growth, ebb and flow of population during past periods.

Man belongs in the order of mammals. In his growth there has been developed the type of mammal enforcing the production normally of one offspring. This feature is considered as one of the evidences of the high and mature development of man. Coordinate with the slow birth-rate of man appears the feature of the care of the offspring, helpless through a continuing period. The effect of this on the development of future population can be seen. With this apparent handicap it is evident that the species of man as a natural animal would have made very slow progress in populating the earth. This is exemplified in the far-descended lines of the great apes, which, so far as is known, never have shown the character of fecundity leading to great numbers of individuals that is observed in other groups of mammals. The apes, it may be conceived, were animals set apart by bodily characters and habits not necessarily to become man, but in whose stem the man being could and would develop. The physical preface to man, it is thought, would not require adjustment within large groups as is conceived necessary for the populational impetus to man's culture advance. Man-like beings in the stage of beginners as described were not intruders because they were beings developing along natural so-called laws of environment, and so forth. They were static or delimited. However, these man-like beings, or some

of them, had within them the germs of certain capabilities based on physical form, members and attitude. Tool using and language capabilities may be referred to. The development of these extra facilities must eventually class these beings, having become man, as intruders in the slow-moving scenes of nature. So it may be put forth that, without the acquisition of several arts or sequences of artificialities governed by mind of a higher quality than previously developed, the consideration of population would be useless.

In the earlier stages represented by the artifacts of some of the man stem it is conjectured that the population was nearly stationary. That the man stock persisted through geological changes in his environment and that through very long periods of time he was subject to unknown causes of mutability is beyond question. That his arts also persisted, slowly developing at first and gradually at a more rapid rate, is evident in the sequence of layers containing the indestructible artifacts from his intelligent labors. Man is seen as becoming man through his arts. The lines of this development showing always advancement in the basic arts are clear. The genealogy of the workers still shows many gaps, hoped to be filled in the future. In view of the number of earnest students and the wide-spread knowledge of the conditions of the problem, the lacunae of skeletal remains may be filled sooner than anticipated.

In considering population the time element is important. The strata containing artifacts, found at various horizons, mean either the accumulations of many workers in a short time or the product of few workers over a long period, presumably the latter. The time scale of the classified periods given by archeologists, though tentative as to duration of the periods, appears to answer this question in the negative regarding numerous population at any time before the Neolithic.

The discussion on these facts would consider the culture stage, the animal and vegetal environments as affecting the increase of population. It is a fact that meat-eating hunting tribes have a slow rate of increase. The first important stabilization of man admitting of increase of population was pecudiculture. The second, which is greater and on which our population increase is based, is agriculture, beginning with the gathering of natural crops of food plants. Observations on tribes lowest in culture among present man would have a bearing here and bring out the fact that the Negritos, Veddahs, Australians and others which could be mentioned have a very limited increase. It is seen that climate, food, housing, care of infants, etc., are involved in this inquiry.

In view of the foregoing speculations which only attempt tentative conclusions to the contents of our present knowledge of the growth of man mentally, that is, in his arts and as an inhabitant of the earth, we can not assume any numerous population before the Neolithic. The Neolithic, it must be observed, is a very short step back in man's history.

When we come to consideration of Neolithic man we are freed to a large degree from the necessity of speculation. Men with Neolithic culture have survived into historic times and from them much may be gathered to show that the stone art which gives the period a name was in reality subsidiary to wood, textile and other material phases of the culture. Considering the Neolithic from the European stations, which are classic to the archeologists, there is seen not what geologists term non-conformity, but a zone of transition between the Neolithic and the preceding culture. There evidently appeared something which profoundly differentiated the

Neolithic, and this may be called the elaboration of the arts and industries. As a further characterization the Neolithic is the dawn of the industrial age and it is at once marked by a mediocrity of art feeling and the multiplication of forms. There is shown the increase of population far beyond the sparse peopling of earlier times. This argues for an organization of the means of sustenance, a development of agriculture, transportation and commerce. The needs of the many are the fertile ground of invention.

Taking up the arts we find the beginning of ceramics with all that implies as to household life, and an early use of fire in industry. The ceramic industry is one of the outstanding features of Neolithic culture. The art of pottery making would seem to contribute importantly to the succeeding age of metals as suggested in another paper.[1] As with the Neolithic culture the same may be said of Paleolithic culture and possibly as to Eolithic. The remarkable point is that each of these groups has individuals with possibilities of culture advance equal to that of the civilized groups. They also appear to show types of intellect, disposition and the like and of physical make-up similar to modern men who have long been subjected to the mass of inventions of the age.

It is evident that a culture pattern underlies our human make-up, the same with all races, nationalities and linguistic stocks. Upon this is based the thesis that it is numbers that make for the advance of culture provided other conditions are equal.

An estimate of the population of the world during the index periods may be tentatively put forward here. The Chellean may be put at 5,000, growing slowly through the Old Stone periods to the Neolithic, which may have had 1,000,000. The Bronze Age would be assigned 1,500,000; the archeologic Iron Age, 20,000,000, while the present has about 1,600,000,000. Thus the wide sweep of important advances of the human race is accompanied by great increase in population. The interesting subject of population growth has been lucidly treated by Dr. Raymond Pearl. Dr. Pearl concludes that the increase in numbers is slow at first, rises with increasing rapidity until a saturation point is reached, at which time stability is attained and no further increase takes place. As seen in ancient examples, currents within the mass producing local condensations and eras of well-being have the effect of promoting the culture of the whole body.

Again and again the observation is made that after the initial impetus given as suggested by increase of population needs, a general conservatism in arts supervenes, little affected by local or periodic adjustments. This is observed in Egypt throughout the long scale of art essentially permutations and combinations of the Thinite impress from dawn to extinction upon which no innovations could make an impress. Thus the schools recognized by Professor Maspero—Thinite, Memphite, the Theban, the Hermopolitan, Tanite and the secondary schools of the Said and the Delta—appear to be responses to population pressure in a broad sense.

Clearly while the facts seem to show that under the stimuli of increased numbers culture takes on a new advance, the effect of the presumed law in dense populations is often annulled by unfavorable conditions such as overpopulation and the consequent struggle for subsistence. Thus Dr. H. J. Spinden has shown that Java has a density of population of 730 to the square mile. This increase has mounted in recent years, but with it no results of invention or other culture phenomena have been

[1] "Man and Metals," *Proc. Nat. Acad. Sci.*, Vol. 2, March, 1916.

observed as yet, due no doubt to the limited operation of the time element. The characteristic culture of this island took form many centuries ago, presumably through acculturation from India modifying the native base.

As to the quantitative and qualitative ratios between population and culture no data can be furnished. It is not clear that such data for ancient times are within the possibilities at present. It can be shown, however, that important inventions or even whole series of consequent procedures originate at favorable phases of human progress. Basically culture is a response to needs which can be supplied only from the conditions of human environment at the time.

A great discovery is due when we are able to correlate the effect of material culture and surroundings with the development of man physically, mentally and morally. What we will discover is the force exerted by material culture, its expansive and propulsive dynamics.

Incidentally, the belief in man's superiority in nature was inevitable, and the idea unfortunately complicated world beliefs tremendously. Man's progress from a rude state prefigured in the Edenic account lost sight of, he stood out at say 1500 B. C. as a unique phenomenon in nature, to account for which a special creation was required. There was, in brief, no other explanation adequate in the consciousness of the supremacy of man.

Whatever man's future, his origin and development into man through all the lower stages were on a definite line—shall we say predestined from the first? There was no course of evolution by which a race of horses or grasshoppers should inherit the earth and attain to organized society of civilization. All things worked out for the development of the hand that should discriminately grasp tools and lay together fire on the hearth, the tongue which should be free to form speech and the mind that should correlate activities and ideas. In all these interacting forces we may recognize a plan so comprehensive and majestic as to form the pattern that underlies human history.

There is seen the line of coming man, never obliterated through all vicissitudes. There is seen man disengaging himself from the heavy trammels of unconscious nature and by each advance helping himself to more permanent continuance. The conception of the ascent from cell to man, jealously guarded through enormous time, is an ennobling thought harmonious with the logic of creation.

HOW SHALL WE MEASURE THE QUANTITY OF LIFE OF AN ORGANISM?

By Professor ALBERT P. MATHEWS
DEPARTMENT OF BIOCHEMISTRY, UNIVERSITY OF CINCINNATI

MATTER in the non-living state possesses electrical, magnetic, mechanical and geometrical properties. All these different properties can be measured and the quantity of matter expressed in terms of any of them. No method exists, however, for determining and expressing the quantity of vitality that same matter shows when organized into a living being, nor can the quantity of matter in such an organism be expressed in terms of units of vitality. Yet vitality is a material phenomenon and is just as much a quality of matter as is any one of the physical properties mentioned.

Since the discovery of a means of measurement of any particular quality of matter has always been a necessary step in the discovery of the nature and laws of the quality itself, and a science becomes exact, rather than descriptive, only when such a method has been discovered, biology, since it lacks any method for measuring the quantity of life, remains in the descriptive and qualitative stage. It can not escape from that stage and become an exact science in which certainty takes the place of conjecture until such a method has been found.

While several of the physical phenomena of life can be measured, as, for example, the rate of respiration, the basal metabolism or the electrical current which accompanies all forms of vital activity, yet since none of these phenomena is exclusively confined to matter in the living state, we are at a loss to express the quantity of life in terms of any one of them. But the principal objection to all these methods, even though they might be standardized in terms of units of vitality, is that what is measured by them is not the organized vitality of the organism. So much of the human body is outside of the nervous system, which is the part concerned with individuality, that marked disease or depression of this system may be present and yet there be little or no change in the total metabolism of the body. A man's muscles and glands may be of normal vitality, and yet his nervous system be so far from normal that his real vitality as a man may be extremely low.

To devise some method of measuring the amount of vitality it is necessary to get a clear idea at the outset of just what it is we should try to measure. What is vitality? What, if any, are the particular and exclusive, objective evidences of the existence of the integrated vitality of an organism—of its individuality — which we might measure? Neither chemical nor physical phenomena are known which are exclusively confined to living matter.

There are two, and I believe only two, characteristics of life which are not shown by any non-living thing. There are two characteristics which matter exhibits when organized into the state called living, and which it does not show, although it probably possesses them, when it is not so organized. These two characteristics are consciousness and will; consciousness and power of action. Not only are these the fundamental and characteristic things in the lives of every one of us, but it is certain, or so it seems to me, that they are equally fundamental for all forms of living matter. All

living things, without exception, show something of the same power of action of an internal source which we show; and they all show power of choice and of learning, a behavior which clearly indicates that they have some form or quantity of consciousness. Consciousness is, indeed, simply another name for being. To be, to exist as an individual, is to be conscious; to have some awareness and power of thought as an individual. And to have will, is to have an internal power of action.

Living things differ in their behavior from lifeless things because they possess these two characteristics as living units or wholes. The individual is conscious and has will and acts as a whole. The amount of its life as an individual and as a whole—not its life as the summation of the lives of separate tissues and cells—is shown by the amount of consciousness and will it possesses as a whole or unit. There can be no doubt, also, that these phenomena of unitary consciousness and will depend on some sort of organization which is peculiar to living things, for any disorganization of a living thing is invariably accompanied by the disappearance of these qualities; and when they disappear the organism is dead although the life of its individual cells may persist. A tree is a less well organized living unit than a man, and it undoubtedly has weaker powers of consciousness as a tree, and a weaker will, than man has as a man. Its powers of action as a tree are small compared with those of a man, and its consciousness as a tree is probably very feeble. Its individual cells, however, are presumably just as efficient as are those of a man; they may be just as conscious and have just as good a power of choice and of action as the individual cells of a man; so far at least as one can judge. The difference between tree and man is a different degree of synthesis or integration into a large living unit which has consciousness and power of action as a unit, as a whole, and is not simply an assemblage of parts. In this respect man is vastly superior.

We come then to the conclusion that matter when organized into what we call the living state shows the two phenomena peculiar to living things of consciousness and will, and these pertain to the organism as a whole. These, then, are the truly vital characteristics. They are not shown by any dead organism, although they may, and I think probably do, lie concealed in such dead organisms. Our problem is to find a method by which consciousness and will can be measured physically and expressed in physical units.

To measure the quantity of vitality of an organism, as an organism, we must, then, find a method of measuring the quantity of its consciousness and will which it possesses as an organism, rather than the sum of the individual consciousness and will of its cells. What I want to know about my own vitality is not how much vitality I have in my muscle cells and the other cells of other tissues, but how much vitality is synthesized or integrated to make me; to make my personality. Every one instinctively feels that his body is not he. For it is upon this integrated portion of vitality, and not upon my basal metabolism, that the intensity of my consciousness, power of thought and of action, and strength of will depend. If I am etherized, for example, or rendered unconscious by a blow on the head, my consciousness and power of will are altogether lost. My integration (organization) is temporarily done away with. I temporarily die. But the basal metabolism of my muscles, bones and glands is very little altered. So, also, I may be in a katatonic state, such as that of dementia praecox, with almost no automatism, with little power of will and very little consciousness, and yet if my vitality be measured by my basal metabolism or by the amount of my respiration or by the electrical reactions of

my tissues, it will be found to be almost normal. Evidently these methods, while they may be a partial measure at least of the vitality of my tissues, do not measure that vitality which is I; and it is this latter which constitutes the vitality of the organism as an organism, as a whole or unit. The better the organism—the more perfect its living organization—the stronger will be its personality, the stronger its will, and the more intense its consciousness and power of thought. Such an organism, for example, as Leonardo da Vinci is one of the most perfect which has been produced. We want a measuring scale which will enable us to measure accurately the amount of this vitality in a Leonardo da Vinci—his vitality as Leonardo, rather than the vitality of his separate muscles, bones and glands. Any good pugilist would probably show just as good a vitality in the latter sense as would Leonardo, perhaps a better; whereas the real life of Leonardo, as Leonardo, is vastly superior to that of the pugilist.

I can make clearer what it is necessary for us to measure by considering another kind of organism, a dead organism, a magnet. A magnet is an organism of such a kind that the magnetisms of the individual particles composing the magnet are organized into a whole. This organization brings its concealed property of magnetism into the clear light of day, for it makes a large magnetic unit for us to see and study, in place of the very little, individual magnets of the particles of which it is composed. The axes of these magnetic particles are so organized by being similarly directed that the individual fields of the particles no longer mutually extinguish each other, but fuse to make a large magnetic field. If a piece of soft iron showing no external magnetism be acted upon properly, that piece of soft iron will be converted into a magnetic organism, a personality or individual. Now the magnet so formed may be a good or poor personality. Its magnetism may be strong or weak, depending on the excellence of the orientation—that is, the excellence of the magnetic organization—of the particles of which it is composed. What we want to know about the magnet is not how much total magnetism there is in it, the sum of the magnetisms of its particles, but how much of that magnetism is organized, synthesized or integrated into an individual. The total amount of magnetic flux in the iron of which the magnet is composed is probably unchanged whatever is done to the iron. But the more perfectly it is organized, the better is the magnet as a magnet. If the magnet be heated, its personality is lost. All its external magnetism, its personality, disappears; it becomes simply a lump of iron; but the total amount of magnetism in it is still there and unchanged. All that has happened is that heat has destroyed the organization. When the power of a magnet is measured, what is measured is the quantity of its magnetic personality, not the total quantity of magnetic flux in the magnet.

It is just so, I believe, with the phenomena of consciousness and will. These phenomena are probably in all matter; but only when the particles of that matter are oriented in a certain way is there produced out of that matter conscious, willing individuals. If a man be anesthetized or killed, or even if he sleep, the total amount of consciousness and will in his body is probably not altered; all that has happened is that the organization has been temporarily or permanently changed, so that the mental fields of some of his molecules are variously directed and he is partially disorganized and resolved into a chaos of atoms, molecules and cells.

The real vitality of any organism, its individuality in other words, can only be measured, I believe, if there be about that organism what may be called a vital or mental field. If such a field exist and we can find a means of measuring it, then

we will have a means of measuring organisms as organisms, and of comparing one organism quantitatively with another. When we discover this method then we may discover whether or not there has been a real progress upward of evolution, for we shall be able to compare the mentality of a bacterium, or any other organism, with that of a man, and classify all living beings in a real classification based upon the quantity of their organized vitality per gram of matter.

Is there any reason for thinking that such a field exists?

Such a field must exist, if the hypothesis as to the nature of matter developed by the author be true.[1]

In the book just cited I have developed the conception that matter is four dimensional. It extends in space and endures in time. So much, indeed, is a truism. These four dimensions look qualitatively different to us, whether they be qualitatively different or not. There are, hence, four aspects of all matter, corresponding, each of them, to one of the four axes of space-time. These four aspects are the mechanical, the electrical, the magnetic and the mental. Every electron, whether positive or negative, has these four aspects or qualities. Consequently in every event in nature there are mechanical, magnetic, electrical and mental components. These four events are in the four planes of four-dimensional space, for the electrons are conceived to be four-dimensional vortices which are either strained about all four axes, on the geometrical or formal representation of the cosmos, or have four components of motion, one about each of the four axes, on the mechanical representation. Each electron is surrounded by a field of stress and strain which extends indefinitely outward from it, which may be called an epi-electron, and which we recognize as the electrical field of the electron. In this field there are the same four components, and of the same amount, but oppositely directed, which are in the electron. Thus in the field there is virtual electric charge, magnetic flux, mechanical strain and mental strain, corresponding each to a real similar factor in the electron itself.

Corresponding to these four aspects of matter there are four kinds of organisms: the magnet, the electet, the crystal and the living organisms, or *mentets*, as I suggest they be called. In the first kind of organism, the magnet, the particles of which it is composed have their magnetic axes arranged in parallel; in the second kind of organism, the electet, the particles have their electrical axes arranged in parallel; in the third kind, the crystal, the organization is by the mechanical axes of the molecules or particles. In these mechanical organisms the hidden shapes and mechanical properties of molecules are made manifest to us; in the fourth kind, living organisms or mentets, the organization is by the mental axes of its particles. In them the property of mentality present in all matter is revealed to us. The fundamental material organization in living matter is mental.

Since every electron has the same amount of each of these four elements or qualities, and since by vitality we really mean consciousness and will, to determine the total quantity of vitality in any organism all that is necessary is to weigh it. The fat man has much more by this measure than the lean. But the scales do not show the amount of vitality which is the man himself; nor do they show the amount of his vitality considered as the sum of the vitalities of his different cells as vital units. They measure only the total vitality of all his electrons, since this is proportional to their weight or number.

How then shall we measure the integrated vitality of a man?

[1] "The Nature of Matter, Gravitation and Light." Wm. Wood and Co., New York. 1927. 218 pp.

The field about a magnet is essentially a magnetic field; that about an electet is essentially an electrical field; the field about a crystal, or about a material body strained mechanically, is a mechanical or elastic field; just so, I believe, the field about a living organism, or mentet, must be a mental field. The only way of measuring the strength of any of these organisms, as organisms, is to measure the strength of the corresponding surrounding field. How are we to do this in the case of living organisms?

There are two ways, I believe, which we should seek to follow and which may lead to the goal.

We are essentially mental organisms. So much is I think indisputable. A very, very small part of our matter, probably only a portion of the nervous system, and possibly a very small part of that, is so organized that it is a mental unit, and so connected with the rest of the body through nervous connections that, weak though it be, it can act upon the body by its mental force so as to release the body's energies and produce mass motions. In order to do this the possibility exists that all that is necessary is to change momentarily the orientation of some of the mentally polarized molecules of the nerve cells, and that this pulls the trigger, as it were, for the release of amounts of energy which are needed. The mental force, though weak, is a material force and like any other force is able to act upon matter polarized in its own sense, in this case matter mentally polarized, and the extremely small mass of the molecules moved makes it possible for the weak force, which we call will, to act physically and efficiently. For if we are mentets, we are almost certainly weak mentets, since the amount of matter in the real mentet of each person is probably very small, though how small can not be said. The smallness of its amount does not mean that it is inefficient, for the lives of very minute organisms, organisms too small to be seen even in the microscope, show that even very small collections of molecules, when they are properly organized, may be very efficient mentets, with consciousness and will sufficient to meet and overcome the usual vicissitudes of life.

To solve the problem of how to measure the supposed mental, or vital, field of an organism, I believe we must be guided by the experience of physicists in measuring their organisms of an electrical and magnetic nature. It seems that each of the aspects of matter just mentioned acts only on other matter through that aspect of such matter which corresponds to its own. That is, if the electrical charge on any object is to be measured, it is necessary to bring near it matter which is electrically organized; to measure magnetic flux the matter having the flux must act on matter so organized as to be a magnet. And we measure fields of matter strained mechanically by mechanical means. We do not detect magnetic flux by an electet; nor electric charge by a magnet. Nor can we expect to move any mass of matter by mental force unless that matter be so organized as to act as a mental individual. Otherwise the different particles composing the mass of matter, having their mental axes variously directed, will be moved in various directions, and there will be no movement of the mass as a whole. If then we are to detect such a supposed mental field about organisms, other highly sensitive mentets must be found which will react by molar motion of their matter when brought into the fields of such other mentets as we are. Since we are probably weak mentets, although possibly the strongest existing, we must either make very sensitive artificial mentets of small inertia, or we must find natural mentets, other living organisms for example, of intense mentality but small mass, so that they will react to a weak mental field.

It might be possible by observing such organisms to detect a change in their

motion or behavior when brought near a human or other living being, and in this way, by using these natural mentets, a method of detection and measurement of the mental field, that is of the vital field, of man and other organisms could be obtained. The strength of the field could thus be expressed in terms of so many ergs of mental energy per cubic centimeter, if the energy necessary to move the organism in question with a definite velocity were known. Thus the quantity of the real vitality of the organism, as an organism, could be expressed.

There is, however, another possibility which should be borne in mind, and here again we are guided by the history of magnetism. It may be possible to make artificial mentets which are not living in the sense that they are capable of growth and reproduction.

Originally, when knowledge of magnetism was young, the only magnets known were those found in nature, the lodestones. Then it was discovered that new magnets could be made by acting on iron by such preexisting magnets. But to make a magnet one had to have first another magnet; and it was a great question how the first magnet came to be made. At that time students of magnetism were confronted by the magnetogenetic law: every magnet from a preexisting magnet; just, as at present, we have the biogenetic law: every living organism, every mentet, from a preexisting living organism (mentet). Ultimately, however, it was found that a magnet might be made by acting on certain kinds of matter not by magnets but by an electric current. This was the artificial creation of magnets. Moreover, it is known that certain crystals, in which the organization is preeminently mechanical, have in addition a certain amount of electrical organization so that the different crystal axes have different electrical and also magnetic polarities. Now the possibility exists that in a similar way some kinds of matter, when organized either magnetically, electrically or mechanically, may also show some mental organization. Such matter would then be a mentet of an artificial kind, although it would probably lack the power of metabolism and machinery of action which characterize living mentets. Should such a chance discovery be made, it might be found that such a crystal, or electet, would be oriented if brought into the human or any other sufficiently strong vital field. And this might solve our problem. But this would be largely a chance discovery and I imagine a great many negative experiments will have to be tried before such a mentetometer is discovered, if indeed it be ever found.

In these two ways, then—first, by testing small living organisms (natural mentets) and looking for changes of behavior or orientation when brought near other organisms; and, second, by looking for artificial mentets produced mechanically, electrically or magnetically—it may ultimately be possible to demonstrate, and to determine the strength of, the mental field which, if the theory of matter I have published be true, exists about every living individual, and which alone expresses the strength of its personality and its vitality as an organism.

There is also another possible method of measuring this organic vitality which we may briefly consider.

If the objective aspects of consciousness and will could be identified, then we might measure the quantity of vitality in an organism, the strength of its field, not mentally, but in terms of such other objective things. Let us consider this possibility a moment.

What is the objective, mechanical aspect of consciousness? In other words what do we call consciousness when we see it in other objects than ourselves? For, of course, we do not recognize it in them as consciousness. Now it seems to

me that the objective, mechanical equivalent of consciousness is time. That which is in us consciousness, appears to us in others, when they are viewed as machines, as time. Time is a concept of mechanics. And its geometrical, as distinguished from its mechanical, aspect is one of the four extensions in space-time, that is in four-dimensional space. What the electrical and magnetic aspects of consciousness are need not be considered here, although their identification is not difficult. That consciousness is the subjective aspect of time and also of extension in space will be realized, I think, by considering the nature of time. We are subjectively conscious of the objective thing we call the flow of time. It is the succession of states of our consciousness. Time is being, just as is consciousness. Time may be defined, indeed, as that which is, has been or will be. There are three kinds of time, just as there are three states of being: past, present and future; or, I was, I am, I will be. Being is thought or consciousness. Hence time is the objective, mechanical aspect of consciousness or thought. That which in us is our flow of consciousness, we observe in others as a flow of time. Such others proceed from state to state of consciousness. They begin, and they grow old; most grow wiser as they accumulate consciousness or thought.

Time, geometrically expressed, is one of the coordinates of space-time; it is coordinate with extension in space. Hence the time axis of space-time is the mental axis of space-time.

Units of consciousness can then be expressed objectively in terms of mechanical units of time, or seconds; and in terms of geometrical units of time, as so many centimeters. Consciousness can also be expressed in electrical and magnetic units just as soon as the electrical and magnetic aspects of consciousness have been recognized. Its electrical aspect is possibly electrical capacity, since this has the dimensions of an extension in space. The older a man grows, the more seconds he has, the more consciousness he has had. His units of consciousness accumulate, and the quantity of vitality as an individual enduring in time is increased somewhat in proportion to his age. If the intensity of his consciousness at any instant becomes less as he grows older, yet the total sum of his consciousness is constantly increasing with his years. But here again we should have to measure and sum only those seconds, only that succession of states of being, which pertain to him as an organism.

So much then for the objective aspects of consciousness as time and as extension in space.

The objective mechanical aspect of will is undoubtedly force; and the objective mechanical aspect of emotion, or internal power of action, is undoubtedly energy. Energy by definition is that which acts, just as time is that which is. Energy is composed of two factors: it is the product of force by an extension. So emotion, the subjective aspect of energy, is also composed of two factors, and one of these is will, which is the subjective aspect of that mechanical quality which we call force. The geometrical aspect of force, and hence of will, as I have shown elsewhere,[2] is a surface. And the geometrical aspect of emotion and energy, energy being a mechanical concept, is volume. Will can be expressed, if this be so, in units of force, as so many dynes; or in units of surface as square centimeters; or in units of electrical charge. Every force in nature is the objective thing, which subjectively is will. Will, then, is everywhere that force is; and force is everywhere that will is. Power of action, or emotion, may then be expressed externally or objectively as energy, in units of energy, *i.e.*,

[2] "The Nature of Matter, etc.," pp. 19, 42.

ergs. But here again, in order to measure the power of action of an organism, its will, or emotion, the energy of the mentet only, must be measured. It will not do to measure the total energy of the cells of the body but only the energy of that very small part which is organized mentally. This is of course a very difficult thing to do and will probably be impossible. If, however, a method could be found to do it, then the emotion and will of any organism could be measured mechanically.

Vitality, then, which so far as its mental part is concerned is essentially the product of consciousness by power of action, or emotion, may be measured as time-energy in mechanical units of ergs-seconds, in place of mental units of consciousness and emotion. And since energy has the geometric aspect of volume and time that of extension, vitality can also be expressed in cubic centimeters-seconds, or as centimeters raised to the fourth power, as so much four-dimensional extension. This shows us that mentality is simply another name for matter, since matter is also, when geometrically considered, simply four-dimensional extension. But as matter is four-dimensional extension which has been warped or distorted so that it differs from that four-dimensional extension which is isotropic and symmetrical and unwarped and which we call the immaterial, so also the vitality which matter shows or is, is distorted, or mortal, and differs from the immortal form which is another name for the immaterial. Living matter, then, is simply matter so organized that all four of its aspects are shown at once. In it the mental aspect, which is concealed in the lifeless so that the latter exhibits only mechanical, electrical or magnetic aspects, becomes manifest. We can not create life until we can create matter; and to make living matter we shall have to find a means to organize matter by its mental aspects into a mental unity, rather than magnetically, electrically or mechanically. For one thing appears to the writer to be entirely clear, *i.e.*, that an organism is a mental unit. Its organization is then *sui generis;* it is not any of the physical organizations shown by dead matter. Any attempt to explain living phenomena without considering this most important fact seems to be foredoomed to failure. The organization in living matter is material but in its fundamentals is neither physical nor chemical, *i.e.*, mechanical, electrical or magnetic, but mental.

To return to our problem of measuring the mental field about every organism, it may be that the distortion about any one axis of space-time is necessarily correlated with distortion, to some degree at least, about the other three. If this should prove to be the case, and we could find the necessary correlations of the distortions about the different axes, then it might be possible to measure the distortion about the mental or time axis, not directly, but by a measurement of the accompanying distortion about the electrical or magnetic axes. This, however, is perhaps a remote possibility, although such correlating factors for the other aspects of matter are known; the specific inductive capacity being the factor correlating the mechanical with the electrical aspects, and the magnetic permeability the factor correlating the mechanical and the magnetic aspects of matter. The specific inductive capacity is the factor relating mechanical units or ergs-centimeters to the square of electrostatic units; while magnetic permeability relates ergs-centimeters to the square of units of magnetic pole.

We may conclude, then, that what we must seek to measure in biology is the quantity of life of the organism as an organism, that is, as a unit. And that this is, in human beings at any rate, and possibly elsewhere, only a very, very minute amount of the total vitality in the organism. The only possibility of

measuring it that the author sees is to find a means of measuring directly the organism's accompanying field of consciousness and will, if such a field exist about it, for unitary consciousness and will are the only properties of living organisms which are peculiar to them. Such a field, however, must exist if the theory of matter expressed by the author be correct, and organisms may act on other organisms through it. Search should be made for it for I believe its discovery alone can make biology an exact science and convert biological conjecture into certainty.

Finally, it is obvious that the essential and peculiar energy shown in living things is mental energy. In this sense we may speak of mental energy as a truly vital force and energy. It is just as peculiar a form of energy of living things as magnetic energy is the peculiar energy of a magnet or electrical energy of an electet or mechanical energy of a crystal. It is this peculiar and characteristic energy which accounts for all the peculiar and characteristic phenomena of life. For the characteristic phenomena of life are power of choice and action. This mental energy, however, is just as real, universal and material as is electrical, magnetic or any other form, for energy is probably always the same thing and we deal in its various manifestations only with different aspects of that thing. This mental energy can be measured just as soon as we make a delicate mentetometer. It will be expressed in ergs, when found, in the same manner as is expressed its other forms. The amount of such organized mental energy in any cell is probably only a very small proportion of the total, except possibly in very minute organisms. To measure it, therefore, will be difficult.

With the idea that there was in every living thing this peculiar form of energy, as long ago suggested and advocated by Rignano, I was not at first in sympathy. It seems to me now, however, that there is no escaping the conclusion, and in the conception sketched here and developed in my book on "The Nature of Matter," the exact relation of it to other forms or aspects of energy is pointed out. In my opinion it is the neglect to consider this peculiar form of energy which accounts for the difficulty many biologists have had in interpreting vital phenomena and for their differing opinions as to the nature of life itself. It shows that while every organism, including man, is a machine, yet controlling this machine as long as it lives there is a material organization of a kind which is at the bottom neither mechanical, magnetic nor electrical, but mental, which is the individual itself.

TALES THAT DEAD MEN TELL

By Professor JOHN HODGDON BRADLEY, JR.
UNIVERSITY OF MONTANA

SEVERAL million years ago the light of a new era was dawning on the continent of Asia. From the Arctic Circle to the tip of tropical India vast forests luxuriated under a friendly sky. Many a great beast stalked the depths. Safe in the matted branches, numberless bands of tree folk shrieked derision at the snarling enemy below. Here were the ancestors of many long-tailed monkeys and the tailless manlike apes, unconsecrated children of the jungle. Here too was the creature of destiny, alone blessed of all the horde. For Nature had dreamed a dream, and had chosen this one to make it real. Bright in the promise of the new day, the ancestor of man swung slowly toward his destination.

Slowly the land rose, the climate grew severe, the trees languished. The simian paradise became a purgatory, because the very existence of the tree dwellers was interwoven with the branches of their homes. Asia began to buckle in the middle as the Himalaya mountains were born. The ancestral forest was cut in two. Before the barrier rose to impassable heights, many monkeys and apes escaped to India, where their descendants enjoy life to-day in ancient comfort and safety. Others lingered too long in the northland. Slowly the mountains grew, the climate became colder and drier, the forest shrank. Cut from escape to the south, the bedeviled remnant of the happy horde met death. Some starved with the dwindling of the trees and tropical fruits. Others tried life on the ground. But here were the teeth and claws of bloodthirsty enemies, and many weaklings succumbed. It is not surprising that but one of all the forms survived, a lone victor in an unfair battle. But this was the creature of destiny whom fate had chosen to be the father of humanity.

The forerunner of man came down from the trees reluctantly and only as a last forlorn hope. He had been just a skylarking vegetarian, in an easy, friendly world. On the ground his old fruits were missing, food of any kind was scarce. The cold, dry climate was an increasing menace to his health and happiness. His teeth were too weak, his claws too dull to protect him from the powerful foes of his new environment. And he lacked the equipment for running away. The whole world was out of joint. His only friend was the latent power in his brain. He must learn to outwit his surroundings or die. He learned because in him was some of the stuff that men are made of.

Through many generations the apelike bodies of his descendants were slowly molded for life on the ground. Countless individuals, unable to conform to the new demands, perished. But slowly out of the survivors emerged the human body. Arms were no more needed to swing their owners from branch to branch, so they became shorter. Legs grew longer. Thighs straightened to bear the weight of the body. The great toe became greater, and lay parallel to the others so that the creatures could walk on the soles rather than the sides of their feet. Erect carriage was slowly acquired. Hands were freed from locomotion to become instruments of the mind. They lifted the burden of defense and food-getting from teeth and jaws. The teeth, no longer a vital necessity, degenerated, so that to-day the dentist fights a losing battle in the human

mouth. The power of the jaws waned. With the growth of intelligence, muzzle and brow ridges grew smaller; brain, skull and chin grew larger. Slowly the human face took shape.

With hands no longer tied to the branches, the precursors of modern man learned to protect themselves with clubs and stones. But this was not enough. Cold weather continued to creep out of the Arctic. Plenty of food and clothing was necessary to carry them through the long winters. They must turn hunters and track the great beasts to their lairs. The men of the dawn did this and more. They made the discovery which Remy de Gourmont called "the most characteristic act of genius of which mankind can boast." They discovered the use of fire, without which further progress would have been impossible. At last, before weapons, clothing and fire, the barriers of climate and foe were down. The early men were able to roam in all directions, to take up cooperative living, to invent articulate speech, to sow the seeds of civilization.

Such is the scientific story of the ascent of man. It is largely the product of imagination. No scholar would maintain the truth of its details, for decay has obliterated much of the tangible evidence of man's climb from the abyss. Yet no scientist doubts the broad truth of the story, the rise of man from apelike ancestors.

Whatever may be our prejudices, we can not take man out of the animal kingdom. It is not an insult to the spirit to admit that man is a mammal. Like other mammals he suckles his young and has a backbone, warm blood, hair, separate chest and abdominal cavities. It is rather a defect of the spirit to deny such an obvious truth. Among mammals the position of man is equally clear. He is certainly no close relative of the duckmole or the kangaroo because he neither lays eggs nor carries his young in an abdominal pouch after birth. But he does belong to the mammalian group whose young are nourished before birth by the placenta. Among these he is only remotely like whales, elephants, beavers, cats and cows. Whether we like it or not we must admit that he most resembles the apes. His legs, arms, feet, hands, teeth, posture, even his blood and his brain are strikingly apelike.

The similarity of man and ape suggests that both descended from a common ancestor. The rock record of the past goes a long way towards proving it. Although the truth about the progenitors of man is obscured by the mists of time, it is not entirely hidden. The bones of extinct men and manlike creatures, though rarer than precious jewels, are eloquent of the history of humanity. Some people deny the tales these dead men tell. But fossil men can not lie.

On the island of Java, along the banks of the Solo River, are rocks long known to contain the bones of fossil mammals. In 1890 the Dutch government sent Eugene Dubois to explore these deposits. Work continued for several years and large quantities of bones were unearthed. The fragments of a single specimen will be remembered long after its flimsy stuff has crumbled away. For the skeleton is that of the Java ape-man, perhaps the most significant discovery ever made in the rocky tombs of the forgotten.

Skull cap, left thigh bone and three upper molar teeth were all that had escaped decay. But these are enough to prove the former existence of a creature more like a man than any living ape and more like an ape than any living man. The skull was only two thirds as large as the skull of modern man. The size of the brain must have been between that of the highest ape and the lowest man. The brows were overhanging, the forehead low and flat. The nearly

straight thigh bone tells us that the creature was as large as a man and walked erect. The teeth were more apelike than human. Most authorities agree that the Java ape-man was more human than simian, although perhaps not in the main line of development to the men of the present. Marcellin Boule, the distinguished French paleontologist, and a few others believe him nothing but a large and special kind of gibbon. Whatever the truth may be, whether he was our granduncle or our grandfather, or just a glorified ape, the Java ape-man breaks down the barrier between ape and man. He is just the sort of creature that should have existed if ape and man share a common ancestor.

Though far below the lowest human of to-day in all the prized blessings of mankind, the Java ape-man may have ruled supreme in his day. And that day was scarcely more than half a million years ago, an almost negligible fraction of geological time. Since then humanity has traveled so far from the apes that the mere mention of a simian origin is disagreeable to many people. But evolution does not usually move at so rapid a pace. Sir Arthur Keith believes the Java ape-man an old-fashioned survivor of a former epoch, and that somewhere there existed a contemporaneous but still undiscovered race with more of the characteristics of modern man.

The intelligence of even the earliest human beings is the thorn in the side of the scientist in search of origins. Man, primitive as he was in the early days of the glacial period, was not the creature to die a fool's death. The Java ape-man was undoubtedly the victim of drowning. His bones were quickly sealed from the air by the river sediments, and preserved from decay. But his friends and relatives escaped such accidental embalming and died on the plains or in the forests where their bones turned back to dust. Death by drowning before the days of navigation must have been exceedingly rare, and most other deaths robbed time of its record. When early men learned to avoid drowning and to bury their dead in the earth, they learned to destroy the most significant proof of their existence. For bones rot unless tightly sealed from all the cankerous cohorts of decay.

So it happens that the remains of the Java ape-man stand alone in their antiquity. From time to time new discoveries have been made which threatened the isolated glory of the bones from Java. But the new finds proved to be either not so ancient as first thought, or too poorly preserved to tell a clear story. Some of them were found to be not human at all. Recently the bones of a creature resembling a human child were unearthed from a rather old deposit in Australia. When a complete description of these remains has been made, science may know whether or not it has found a close relative of the creature from whom modern man was descended. The skeleton is undoubtedly not old enough to be the actual ancestor of the men of to-day, and it is too much like an ape to be classed with even the lowest of men. So too in other continents; North America, South America and Africa have yielded no fossil traces of undoubted men comparable in antiquity with the fragments from Java.

In Europe the bones from Piltdown, England, have long been discussed. The skull is clearly that of a manlike creature, but farther along the road to true humanity than the Java ape-man. The jaw is apelike, and some authorities believe it the jaw of an ape that resembled the chimpanzee. If the skull and jaw belonged to the same creature, the Piltdown man was primitive, a true ape-man, who lived perhaps one hundred and fifty thousand years ago. Though one of the oldest of Europeans, he does not deserve

the name of "dawn man" which science has given him. That name belongs to the more primitive man of Java.

Even older than the "dawn man" of England is the man of Heidelberg, whose position as the very earliest known European can not be contested. Although he bequeathed his lower jaw to the world and nothing more, he has the unique distinction of being the only fossil man about whom all authorities agree. He lived in a warm age, probably between the second and third advances of the great continental glaciers of the Pleistocene period. The massive, chinless, apelike jaw with its primitive manlike teeth is just what one would expect of this remote creature. He was neither true man nor true ape, but a transition type with the characteristics of both.

Possibly the direct descendant of the Heidelberg man was the man of Neanderthal, the best known of all fossil men. Several specimens from various localities in western Europe tell the story of this widespread race. The mark of the beast was still heavy upon the Neanderthals. They were little more than five feet tall, and walked on short limbs with an apelike stoop. Their skulls were large, and heavy brow ridges met across the forehead. Chins retreated, teeth projected, heads were thrust forward. Brains were large but primitive. Despite all this the Neanderthals were men, the first of the cave dwellers. For they knew the use of fire, and made tools and weapons of fine workmanship. But more than this, they buried their dead with reverence and proved that in their hearts was stirring the first faint feeling that death does not kill all. They ruled over Europe for many thousands of years. Near the close of the last glaciation they were driven to their doom by the first of the moderns, the stronger and more intelligent Crô-Magnons. This happened perhaps twenty or twenty-five thousand years ago. From then to the present, the story of man is an unbroken chain.

It is unfortunate that the chain is not complete in back of the coming of modern man. With the available facts science can not know the exact history of mankind. No primitive fossil man thus far discovered can be the direct ancestor of the first modern man. Yet the evidence is conclusive that creatures once lived who were neither apes nor men, but both, and that with time these creatures became more human. Their bones all tell the same story of the lowly origin of man, and their bones can not lie.

To-day man is far removed from any living ape, for man has gone forward and ape backward. Yet man is also far from the gods. The ego should be pleased to see man the glorious result of infinite striving by apelike ancestors, rather than the degenerate descendant of a god. But Nature did not consider our pride when she made us. She cast our bodies in the mold of an animal. No amount of denial will take the beast from our bones. The best we can do is to try to rout him from our spirit.

INSTINCT AND MAN

By Dr. MAX SCHOEN

CARNEGIE INSTITUTE OF TECHNOLOGY

THE study of the nature and significance of instinct in man is far from being merely an academic question. The problem is of fundamental significance, since it deals with man's inborn powers, the nature of the sources and mainsprings of human behavior. Its practical importance is seen most clearly in the popular scientific literature of the last decade dealing with the implication for human welfare of the doctrine of heredity and of the findings of the so-called intelligence test. In this literature we are told that biologically and psychologically the fate of man, from whole races to single individuals, is predetermined by what he brings with him into the world, that is, his instinctive equipment. Two important facts seem to have passed unnoticed in these discussions: first that biology and psychology, although closely related, approach the study of what is man from different angles; and second that biology can speak more authoritatively about heredity than can psychology about instinct. Biology is concerned exclusively with the nature of the heredity mechanism. It has little to say, although it may imply much, as to the nature of the finished product of heredity, the born infant. When biology has determined how the new human organism is formed from the germinal material and what goes on in its embryonic stages, it has finished its part of the work. The rest is for psychology to ascertain. But whereas biology has attacked its problems experimentally, psychology has in the main been guessing as to the basic nature of the material with which it is concerned. With the exception of the work done by John Watson on infants, there is no reliable evidence whatsoever as to the native state of the human material whose education constitutes the main problem of society. William James defines instinct as "the faculty of acting in such a way as to produce certain ends, without foresight of the ends, and without previous education in the performance." So far so good. But what evidences does he cite for this clear-cut, dogmatic statement? His illustrations of the definition are all taken from animal life, and these from the animal adult, and it is upon this dubious foundation that he erects an imposing structure of human instincts. William McDougall's standpoint on instinct, the influence of which has been wide and varied in education, industry and social psychology, namely, that it is "an inherited or innate psycho-physical disposition which determines the possessor to perceive, and to pay attention to, objects of a certain class, to experience an emotional excitement of a particular quality upon perceiving such an object, and to act in regard to it in a particular manner, or, at least, to experience an impulse to such action," simply states in so many complicated and mystifying words that a living organism will probably do something when confronted by a situation, in other words, that living organisms possess life. His array of specific instincts consists of an enumeration of adult activities for which no parallel whatsoever exists in the infant before the period of learning, which means the very hour of its birth. If instincts are native behavior, this native form should be readily recognizable, as in the case of some lower forms of life, insects, for instance, or there is no reason for calling them inborn. If they appear subsequent to the inborn period, what justification is there for

calling them "instincts" rather than habits? But besides the simple reflexes, no act that even approximates to what is called an instinct is discernible in the new-born infant. To read the animal, and even that belonging to the lowest stages of life, into man, is to forget the facts of progressive evolution, while the practice of inferring the presence of instincts in the new-born infant from more or less developed behavior of a post-natal period is to fail to take account of the subtle effects of the environment upon that most sensitively organized machine in existence, the human offspring. The education of this organism begins on the day of its birth, and in its early days every factor in its environment produces an effect upon it the significance of which can be ascertained only by the closest experimental observation. Certainly all the reliable evidence that we possess from Dr. Watson's experiments is against the orthodox instinct creed and in support of the conclusion that there are no instincts as such, and that "everything we have been in the habit of calling an 'instinct' to-day is a result largely of training—belonging to man's *learned behavior.*"

What, then, are we to understand by instinct? And what is the answer to the question whether or not there are instincts in man? Instinct is the scientific trade name for native behavior, or behavior that is present at birth, and which therefore antedates and precludes learning. The study of comparative psychology suggests two causes for the contentious atmosphere that pervades the realm of instinct. One of these causes is the failure to consider instinct from the comparative point of view as an evolution and not a fixed state. The other cause is a like failure to recognize in the make-up of man the vestiges of his animal ancestry, namely, that his psychological constitution retains the landmarks of his biological evolution.

Organisms belonging to different stages in the evolution of life possess native behavior, the fundamental nature of which varies in complexity and flexibility. The simple structural organization of the ameba determines the extent of the world in which it lives as well as the scope of its needs and consequently the scope of its activities. Its behavior is no more diverse than its machinery demands. In contrast to this simple existence of the ameba is the immensely complex life of man, created by a highly differentiated and specialized structure of sense organs, muscles, limbs and nerve tissues. The more highly organized life becomes, the wider is the scope of its activities, since the world in which it lives becomes more extended and varied. Evolution of life represents a spectacle of a gradually unfolding universe from vague, homogeneous chaos, to systematized, heterogeneous order, with a corresponding increase in complexity and specialization of behavior suited to meet the widening expanse of the realm of life. The vague, undifferentiated world of the ameba is met by similarly vague, undifferentiated movements. The very definite, differentiated world of man is reacted to with a large number of definite, specialized actions. The world of the ameba is not the world of the insect; that of the insect is not that of the vertebrate; and that of the vertebrate is not that of the mammal. And the behavior of these organisms is in keeping with the world in which they live.

Running parallel with the increase in the complexity of the environment and of behavior, we find an increase in the flexibility of the behavior. Flexibility means the degree to which the behavior is subject to the moulding influences of the environment. Moulding means possibilities for variation, and therefore, where the possibilities for variation are largest, there we also have the greatest scope for meeting the widest variety of situations.

This brings us to the heart of the instinct problem. Instinct as native behavior can not possibly mean the same

thing for different forms of life. The instinct of the insect is not the instinct of the vertebrate, and that of the vertebrate is not the instinct of the mammal. The difference lies in the degree to which the native behavior is subject to habit formation, or, in other words, the degree of variability of the organism at birth. All native behavior is modifiable from two angles: first, in the situation that elicits a certain behavior, and, second, in the kind of behavior that a certain situation evokes. Thus, as a result of training, a large number of varied stimuli can be made to evoke one and the same specific response, or a number of varied responses may be aroused by the same stimulus. Both these factors imply the number of habits that the animal can form, and the degree to which any one habit deviates from the native behavior from which it springs. And it is the original state of the native behavior that determines both the number of habits that can be formed and the degree of habit formation. When the native material is least variable, the possibilities for the double aspect of habit formation are most limited, that is, the animal can form but few habits, and even the few habits that it can form vary but little from its native reactions. And where the native behavior is most variable, as in man, the scope for habit formation is widest, while the habit resembles nothing that is present in the original behavior. Now variability is in inverse proportion to definiteness of original behavior. Where specific forms of behavior exist at birth, the possibilities for modification or habit formation are most limited. In such cases we can speak of the presence of specific instincts. But in the higher and particularly the highest forms of life, where differentiated forms of native behavior are present in a slight degree, or not at all, we can not speak of instincts, but only of general tendencies to behavior. Native behavior is an evolution from more or less specific native acts to a general mass of random movements which gradually become split up into a large number of specialized single habits. Where native behavior consists primarily or altogether of random movements, there are no instincts, since instinct means inborn specific action, while in man every specific act is an acquired property, formed out of the general chaotic mass of native tendencies. The native behavior of man becomes useful only when it becomes differentiated into habits. A habit is not even a modified or inhibited instinct, since a specific human act resembles in no way anything that is natively present. We can speak of a modified instinct only where, in the finished act, there is easily discernible the presence of the unmodified, native root to which the habit can be definitely referred. There is nothing in the infant that in any way approximates to such developed forms of behavior as curiosity, pugnacity, imitation, etc., which are usually classed as instincts. In fact, the standard criterion for instinct, namely, an act common to a species and somewhat perfect on first appearance, is inapplicable to human behavior. Birds will fly when anatomically ripe, and all birds of a certain species will fly alike. But a child develops an individual manner of locomotion, and it is extremely doubtful, and even improbable, that it would ever walk, were it not for the presence in the environment of factors that induce it to learn to walk. The vocalization of an insect is altogether native, that is, an instinct. But the song of the bird is influenced by the condition in which it is reared. A sparrow reared with canaries will not sing like a canary, but neither will it chirp like a sparrow. The song of the sparrow is thus part native and part acquired, with the native element readily discernible in the finished product. But the speech of man is acquired in form and substance, and no

native element is present in it excepting that it is based upon the native tendency to produce sounds. But the native element is far removed from that which characterizes the insect or even the bird, since the human infant can acquire not only one form of vocalization, but many, and can keep on acquiring them more or less perfectly throughout his lifetime.

We note, then, that instinct is not an invariable something and therefore can not be applied indiscriminately to all living forms. If by instinct is meant anything resembling the native behavior of the insect or even that of the bird, then man certainly has no instincts. He is a bundle of habits, and even these are continually subject to modification. There is nothing predetermined or inflexible in his psychological make-up. If by instinct is meant simply native behavior, then the insect has instincts as such, the bird obeys instinctive tendencies and man possesses a general urge to behavior. The insect comes into the world quite a finished product, the bird less so, and man least so. The insect is born; man is made.

This interpretation of instinct is supported by biological and psychological facts regarding the nervous system, that is, its evolution and its functioning. The evolution of the nervous system from a simple to a highly complex structure is a progressive growth in plasticity of nervous organization, and hence of increased possibilities for modification and control of behavior. Concomitant with this growth in complexity and plasticity runs a higher and higher functioning, from the mechanical reflex to the intelligently controlled and directed voluntary act. The domain of mechanical behavior thus diminishes gradually, until it shrinks into insignificance with the rise of higher nerve centers. In the simplest nervous system, impulses are switched over immediately from receptors to effectors, resulting in trigger-like behavior. In the highly evolved nervous system the impulse is retained in a central station where its final destination is decided upon. The nervous system, beginning as a mere transmission mechanism, becomes a regulating and controlling and deliberating organ. Instincts as such are present or absent in direct proportion to the complexity and the concomitant variability of the behavior. In the simple nervous system, behavior approaches closest to the mechanical reflex, and there we have instincts. In the complex nervous system, behavior gets to be more and more of the nature of directed, voluntary action, and consequently farthest removed from instinct.

We now turn to an examination of another significant problem; namely, does the fact that man has no instincts justify the corollary drawn by Dr. Watson "that there is no such thing as an *inheritance* of *capacity, talent, temperament, mental constitution* and *characteristics?*" This claim of Dr. Watson's is not at all supported by experience and experiment. In fact, in making this claim, Dr. Watson contradicts himself since he admits inherent variations in "structure (including in structure, of course, chemical constitution)."

The structures in which human beings differ are sensory, muscular, glandular and nervous. And *talent, intelligence* and *temperament* are matters of *sensory, muscular, glandular* and *nervous capacity*. Capacity means the readiness with which these structures will permit one to profit by training along a certain definite line, or the degree to which these structures are subject to modification in a certain direction within a certain given time. Thus human beings, whose behavior is essentially acquired, nevertheless differ from each other in degree and type of *acquirability*, so that although man is the most flexible of organisms, we nevertheless find in him a variation at the pinnacle of flexibility,

similar to the variations we found to exist between man and the forms of life below him.

Let us take capacity for musical performance as a case illustration. Whatever the musical performer can do, from the merest amateur to the supreme artist, is an acquired or learned accomplishment. But even under equally adequate instruction accomplishment will vary, because individuals have constitutional differences in those structures that function in musical talent. What are these structures?

Musical talent as a whole consists of a cluster of specific talents of the nature of fundamental capacities. One of these talents has its seat in the very texture of the hearing organ. On the native state of this organ depends the production of such essential artistic effects as correct intonation, delicate nuances, fine tonal timbre and minute differences in tonal durations. Thoroughly standardized tests indicate the marked variations that exist among individuals in native power to respond to these factors. In pitch discrimination, for instance, we find a variation from those who recognize a pitch difference of 1/200 of a tone to the almost completely tone deaf, and no amount of training will turn a dull discriminator into a sharp one.

Another specific talent that functions in musical artistry is technique, by means of which the performer is enabled to make himself articulate. Technique is the ability to express exactly what one wants to express in the way one wants to express it. It is perfectly possible for a person to have keen pitch discrimination and yet play in false intonation simply because the muscles refuse to obey the command of the ear. In other words, technique is in the last analysis largely a matter of muscular fitness, and some muscles are by nature more accurate, precise, speedy than others.

Again, it is not mere chance of circumstance that induces one person to become an artist, another a scientist and a third a philosopher, nor is it mere whim that decides whether one is to become a musician or painter, a physicist or biologist, a psychologist or metaphysician. The more we learn about the endocrine glands, the more convinced are we that temperament is not mere artificial posing, but is something due to differences in vital physiological processes that color and decide the individual's interests and outlook. But the recognition of the existence of native aptitudes, temperaments and mental inclinations does not imply the existence of instincts, and Dr. Watson's extreme point of view in denying talents and aptitudes is more sound scientifically than the somewhat fatalistic instinct doctrine. The marked musical talent of the child is quite a different matter from the pecking instinct of the chick or the flying of the bird, although both are structurally conditioned. The talent needs very careful fostering and can most easily be distorted and ruined, while the chick will peck and the bird will fly unless the one loses its head and the other its wings. Likewise there is nothing fatal or predetermined in temperament, for although its basis is native, its ultimate functioning is environmentally determined, as is amply demonstrated by Dr. Watson's experiments with conditioned behavior in infants. One infant might be born with a greater propensity for anger or fear responses than another infant, nevertheless what arouses fear or anger or the specific form that the responses assume is controlled by nurture and not by nature.

"Man," says J. Arthur Thomson, "has his reflexes and a little instinctive behavior; most of his activity is either intelligent, or was originally intelligent, but has become habitual; the point is that, if occasions arise, man may instantaneously pass from a lower level to that of rational conduct." And man is able to do this in the main because he is least

hedged in and limited by his native equipment. Man is the most intelligent of organisms because he can meet most adequately and most readily the largest variety of most complex situations. In other words, he is most intelligent because he is most educable, his greater educability being due to the plastic state of his native behavior. Intelligence thus means degree of variability of native behavior. Where the original behavior is least modifiable, intelligence is least present, and where it is most variable intelligence functions in its highest form. And since all behavior, including even the simplest reflexes, is subject in some degree to the influence of education, intelligence of some kind functions throughout the entire scale of life until we reach its maximum degree in man. Intelligence does not rule out instinct, nor does instinct exclude intelligence, but both are two phases of one and the same process, namely, adjustment to a situation. The evolution of intelligence is concomitant and coextensive with the evolution of instinct, in that the higher the form of instinctive behavior, the greater is the intelligence. To put it differently, native behavior is instinctive behavior, while acquired behavior is intelligent behavior. But that which is acquired arises out of that which is native. Hence, intelligence is as native as is instinct, since intelligence is conditioned by instinct. That is, that which is acquired and that which is native are basically one and the same, as the acorn and the oak are one.

When we examine the relationship that exists between mind and behavior, we reach a similar conclusion as to the identity of instinct and intelligence. The nervous system is the machinery of adjustment. An adjustment involves the functioning of two factors, a nervous and a muscular activity. The nervous activity consists of impulses of various degrees of complexity, depending on the complexity of the central nervous system: the more complex the nervous system, the more numerous and involved are the impulses. And it is the nature of the impulse that determines the type of the muscular activity. Simple impulses lead to simple behavior, and complex impulses result in complex behavior. Thus, when an impulse coming from any sense organ reaches the spinal cord, it may either travel directly and immediately to a muscle *via* a motor nerve, or it may be relayed to some higher nervous center. Organisms with a rudimentary nervous system, those lacking higher nervous centers or those in whom the higher centers exist in but an elementary form, are capable of but simple behavior that approaches the state of reflexes. The responses of such organisms to a situation are trigger-like, immediate and mechanical, which means least educable or intelligent, since reflexes are the least educable elements of animal behavior. Animals in whom the central nervous system is more highly evolved, or who possess higher nervous centers, manifest a more complex form of behavior, and their responses are more deliberate, more educable, or more intelligent. It seems then, that intelligence and nervous processes are identical, and likewise intelligence and deliberate or delayed behavior are identical. Intelligence is then definable as delayed behavior, and delayed behavior is educable behavior. The longer that behavior is delayed, the more intelligent it is, which means in turn that the number of nervous processes involved is greater before the final adjustment to the situation takes place. If instinct is native behavior, it is clear that the end result of delayed or intelligent behavior is as instinctive for higher forms of life as is immediate behavior for lower forms of life, and there is no ground for drawing a distinction between an instinctive act and an acquired or intelligent act. We may speak rightly of degrees of intelligent behavior, or, which

amounts to the same thing, of degrees of instinctive behavior, since all behavior is intelligent in that it is more or less educable, and since all behavior is instinctive, in that the native element determines its educability. In man instinct makes possible the most intelligent behavior, in the insect the least intelligent behavior. In man, certainly, no act can be said to be either instinctive or intelligent, but is as much instinctive as it is intelligent, since it is the state of man's instinctive behavior that constitutes his intelligence.

The common practice of ascribing a dual nature to man, the one human and the other animal, owes its origin and persistence to the false juxtaposition of instinct and intelligence discussed above. On the basis of this mistaken notion repeated attempts have been made to explain and often to justify the existence of many social and individual evils, while numerous plans have been proposed whereby the instinctive "beast in man," constituting his lower nature, might be defeated by the exercise of his higher nature, or his intelligence. Man, it is said, is by nature pugnacious, grasping, envious, jealous, and at the same time also sympathetic, gregarious and loving. Hence his make-up is not only dual, but mutually antagonistic and contradictory. The function of intelligence must therefore be that of serving as a moral guardian and censor over the instinctive brute, to refine it and to keep it within proper and respectful bounds. Hence the horde of maxims, admonitions and preachments for the control of what is called human nature, the sum and substance of which is summarized in the notion that whereas instinct can not be eradicated it can at least be modified and controlled. This doctrine is the psychological counterpart of the theological tenet of original sin, and, like the latter, has been utilized to justify wars, industrial strife and social and political aggrandizement.

But a preachment is never against an instinct, something that an individual does natively, but always against some individual or social habit. Human beings love nothing by instinct and hate nothing by instinct, but acquire their likes and dislikes in a subtle, but nevertheless detectable, manner. A child can be taught to hate or to love any person or object, and it can be turned either into a pugnacious or peaceful creature, depending on how and where it is reared. Mother love is no more an instinct than is love for one's country or family, a painting or a house. The movement for the abolition of war is not an attempt to eliminate or suppress a pugnacity instinct by intelligence, but to change vicious and destructive social habits into constructive ones. This changing conception of the relationship between instinct and intelligence not only shows up man in a more hopeful light, but also reveals human nature in its true state; namely, that man is a creature of habits, a creature of intelligence, and that his nature is whatever it is made to be by education. The evolution of intelligence and the evolution of instinct constitute a single process, instinct being but another name for intelligence, and intelligence another name for instinct. The highest form of instinct is the highest form of intelligence, and the lowest form of intelligence is the lowest form of instinct, and vice versa. Instinct and intelligence are inseparable. Whatever an organism does instinctively is a sign of its intelligence, and whatever it does by intelligence is an indication of its instinctive state. There is not a single act of behavior that man performs that is either exclusively intelligent or exclusively instinctive, but it is always instinctively intelligent.

Intelligence, then, means the degree of the variability or educability of native behavior. Consequently, just as instinct and intelligence are one, so are intelligence and education. A man displays

his intelligence by what he can do, and what he can do is the result of his education. Man is the most intelligent of animals because he is the most educable, and there is no other indication or measure of his intelligence than his education, or what he can actually do. An infant at birth has no more intelligence than has a bird, although we know by experience that the child will develop more intelligence than will the bird, and we therefore infer that the child has greater intellectual capacity than the bird. The notion of capacity is but an inference from actual accomplishment, but remove accomplishment and you know nothing about capacity. We know of no capacity, as such; all we know of is accomplishment. When we say that accomplishment is in proportion to capacity we are defining the known in terms of the unknown, certainly a reversal of scientific procedure. It may be objected, however, that there must be such a thing as capacity, since for one and the same person accomplishment will vary with varied training, which means that one type of training brings out one's capacity, and another type of training does not. But this simply means that accomplishment depends on the conditions in which the person finds himself, that one set of conditions will bring out one type of accomplishment, another set of conditions a different type of accomplishment, which is only stating that man is a most variable, or educable creature. It may be argued further that often one's accomplishment does not measure up to one's capacity. But this is again only stating in ambiguous terms what is very evident; namely, that experience teaches that accomplishments vary with conditions.

Does the above contention deny the existence of native individual variation? Not at all. Human beings vary fundamentally in muscular and organic structure and texture, and hence in the functions and powers of these structures. But this difference in structure only means a difference in susceptibility to different kinds of environment, condition or training. One kind of temperament, for instance, will be more responsive to a certain kind of influence than will another kind of temperament. The objection to the notion of capacity is its flavor of fatalism or predeterminism, while we know by experience that so long as he is alive, man is modifiable, only that with the advance of years the structure becomes more and more set and less and less variable. But man's power for modification is never completely exhausted, and hence he has no capacity as such, but only possibilities for accomplishment or educability.

To summarize, we find that man is primarily and essentially a creature of education. The education of the human organism begins at birth and continues throughout life. However, human beings differ in intelligence since they differ in structure. But intelligence is not structure but what happens to the structure through education. The structure influences the kind of effect produced by a certain education, and it is for this reason that the same environment will produce different effects upon different individuals. But this does not mean that structure limits education as a whole, but rather the kind of an effect and how much of an effect a certain kind of education will produce upon him within a certain given time. It is therefore education that counts, and not capacity. Man's sole capacity is to be influenced differently by education, and his intelligence is to be ever subject to education.

THE FUTURE OF SCIENCE

By Professor CHARLES A. ELLWOOD

UNIVERSITY OF MISSOURI

SCIENCE is one of the most commonly misunderstood parts of our culture. The average citizen maintains toward it either a negative attitude or only a half-intelligent attitude. The scientific world is in part responsible for these misunderstandings. It is time that the scientific world go to the mat to straighten out these misunderstandings; for they are rooted in the disagreements among scientists themselves. Science is the acknowledged basis of our material civilization. The question at issue is, Can it become also the basis of our spiritual civilization? If so, in what sense?

Perhaps it is unfortunate that the word "science" ever came into our language; for in recent years orthodoxies have been growing up about the word which tend to narrow its meaning unduly. The word originally meant simply "knowledge"; but by common consent, knowledge is not knowledge in the social and cultural sense until it is tested and verifiable. The knowledge which comes by individual experience is so often faulty and fragmentary that only the knowledge tested by the experience of many, and then only by methods which minimize emotion and prejudice, is found in the long run to be trustworthy, and worthy to be called "science." It is "science" in this broad sense of "tested knowledge" whose rôle in civilization we wish to discuss. We shall be only incidentally concerned with science in any narrower sense.

In this broad sense of "tested knowledge" science is fundamental in the process of culture development. Man has always lived by knowledge; and he can live in no other way and remain human. Knowledge is the basis of all his successful adjustments except the few made upon the animal levels of instinct, emotion or accident. It is also the chief means by which man corrects his errors. Adequate knowledge means the elimination of error and success in making adjustments. It is therefore the great source of all mastery over nature, and we believe that in the future it will be the greatest means of controlling human nature and human relations.

The growth of tested knowledge, while it is in civilization the pearl of great price, has been very slow in our human world. It is often said that all primitive man's conceptions were theological and mythological. But this is a mistake. Some tested knowledge regarding the arts of life accompanied the development of those arts from the very beginning. Then, too, it is wrong to put in absolute opposition the magical and theological with the scientific. What we call the magical and theological even among the most primitive peoples often contained elements of tested knowledge. But primitive man had no means of testing his knowledge except by the crudest methods, and therefore what he believed to be knowledge was usually heavily laden with errors. Moreover, uncivilized man had no means of accumulating knowledge except oral tradition. Again, nomadic life, war and other social disturbances in early history interrupted the transmission and accumulation of knowledge. Even after the invention of writing progress in the accumulation of tested knowledge was very slow. The Egyptians and Babylonians made a

beginning and, along with the Greeks, invented many methods of measurement. But even among the Greeks the amount of tested knowledge was very small, if judged by our standards. It was not until the invention of printing in the fifteenth century and the nearly simultaneous invention of certain "instruments of precision" that tested knowledge began to accumulate rapidly and to receive wide-spread diffusion; and it was not until the seventeenth century, the "century of genius," that the scientific movement got fully under way.

Science, therefore, has been the latest phase of culture to receive development, and it seems at first glance absurd to conclude that science is bound to dominate all the other phases of culture. But if we understand the nature of man and the nature of science we will see why this is so. Man is an animal that lives by experience and by what he learns from experience, rather than by ready-made reactions furnished by his germ plasm. Science is the tested knowledge that comes from experience, by using any and all methods which will reduce to a minimum errors of judgment. It is experience tested, verified and universalized. It must lie back, therefore, of every art and it must sit in judgment upon every human mood and upon every form of human conduct. It is, in brief, organized intelligence; and while man can not live through intelligence alone, he will be successful in his living in proportion as he is guided by the accumulated and organized intelligence of mankind. Tested knowledge is, therefore, if our civilization continues to develop, destined to work revolutions in all departments of human thought and action and to become the guiding element in the culture of the future. But if science is to assume this function, then it can be no narrow discipline, hemmed in by orthodoxies and traditional methods; it must itself become a movement toward knowledge of all reality, and take all verifiable knowledge for its province.

Yet the scientific movement still hesitates thus to broaden its scope. Elsewhere the writer has said:[1]

> Like all other phases of culture, science has been subject to all sorts of aberrations. Like all of culture, it has proceeded by trial and error. . . . Even during the nineteenth century science remained relatively undeveloped. It would be fair to say that it remained immersed in its beginning tasks, the exploration and understanding of physical nature, and scarcely arrived at seriously undertaking the exploration and understanding of human life itself. Indeed, there are still many who hold that science can concern itself only with the material and the physical; that it must rigorously exclude from its consideration the psychic or the mental. Evidently science still remains strongly influenced by metaphysical and personal prejudices. It has not yet, at least in a majority of scientific men, attained to the completely open mind.

"Behaviorism" in psychology and sociology illustrates the truth of those statements, for behaviorism in its pure form aims at the total exclusion of the mental or psychic from the field of human science. It, therefore, would exclude a part of reality from the attention of science. Yet behaviorism has become very popular among the younger psychologists and sociologists. In spite of its repudiation by the older psychologists, and even by some of our most eminent biologists, most of the younger psychologists to-day are making haste to climb into the bandwagon of behaviorism. Yet it is manifestly a hang-over from the nineteenth century conception of the nature of science and of scientific method. The scientific movement instead of showing a tendency to take all verifiable knowledge for its province would appear to be going to-day in the opposite direction, or at least to be keeping close to nineteenth century scientific traditions. It must be granted that this is the present trend, and moreover that

[1] "Cultural Evolution, A Study of Social Origins and Development," pp. 246–7. The Century Co. 1927.

this trend tends to become established as an orthodoxy. It may even be granted that so far as the mechanistic method and point of view in science succeeds in obtaining tested, verifiable knowledge, it will command respect and become established. What right have we to expect that science will free itself from restricting orthodoxies and will expand its scope? The answer is that it may not in our time, because orthodoxies when once established in any line of thought are hard to get rid of; but that the probability is that orthodoxies which restrict free inquiry in any line will be outgrown in time because history is a learning process. Man, as we said, is an animal that lives by experience, and science is at bottom tested, verified and universalized experience. This is why it is useful to man, and we may be sure that any attempt to make it anything less will fail in the long run. This is also why we may be sure that any narrow behaviorism in the human sciences will prove to be but a passing fad. What man desires and needs is tested and verifiable experience along every line. But if the whole field of tested and verifiable knowledge be given to science, then what effects may we expect it to have on the other phases of culture, and what new trends in science may we expect to develop?

In the sense of tested knowledge, science may be compared to light in the physical world. It illumines all objects and shows the path of safety as well as dangers. It enables us, therefore, to descry practical values. While it can not furnish us with motives, it may modify our motives. It can even indicate to us possible consequences and so in part reveal the future. It may therefore reveal to us our responsibilities, and become a basis for our faith and hopes as well as for our fears.

All this is equivalent to saying that scientific knowledge has a vital bearing upon both our morality and our religion. But this is denied by both the scientific and the religious dogmatist. Science, they say, can take no account of moral and religious values. But these are the very values upon which science in the sense of tested knowledge does cast its light. Let us at this point content ourselves by carrying out our figure. If we compare science to light, we may well compare religion to vision, not of course the vision of immediate things, but of the remote, the future and the unseen. So Professor Whitehead says,

> Religion is the vision of something which stands beyond, behind, and within, the passing flux of immediate things; something which is real and yet waiting to be realized; something which is remote possibility and yet the greatest of present facts; something that gives meaning to all that passes and yet eludes apprehension; something whose possession is the final good, and yet is beyond all reach.

Now just as physical light is necessary to physical sight, so the light of knowledge is necessary for that imaginative vision which gives rise to our religious faith, if we wish that vision to be sane and true and our faith a reasonable one. Thus may tested knowledge become a foundation for religious faith and science become a more and more dominating factor in the religion of the future. To say that "religion and science are mutually exclusive terms," and that "no union between them is possible" is, therefore, as gross a blunder as to say that knowledge and faith are mutually exclusive terms and have no interconnections.

Even closer is the bearing of science upon morality. If science is tested knowledge, then it should help us to discriminate values; its light should show us the way of safety, not only in the physical world, but also in human relations; not only for the individual, but also for nations. Tested knowledge will not only show us the way of physical and mental health—it can also show us the way of harmony, efficiency and mutual helpfulness in human relations.

Thus right and wrong, in a relative rather than an absolute sense, become scientific categories.

But here we must see also the limitations of science. The light of tested knowledge can not furnish us with motives, though it may make our motives intelligent. Value is a creation of mind, and attaches to objects and situations because of some fundamental human desire. Science can show us the way of bodily health, for example; but if we prefer death, then the way of health will have no value for us. Again, science can show us the way of harmony in human relations, given normal human desires and wishes; but if some of us prefer conflict to peace and harmony with our fellow men, then the way which leads to harmony will for us appear to have no value. To be sure, science may show us the genesis and even the danger and futility of some of our desires; but it is evident that the values which science helps us to discriminate must be practical and relative rather than absolute. The values of science are values only when we postulate the values of common sense, such as that life is better than death, that health is better than disease and that success in life adjustments is better than failure. But if morality is fundamentally a social matter, as practically all ethicists now recognize, then the social sciences must be the chief basis for a science of ethics.

But we are told that science is limited strictly to quantitative measurements and can have nothing to do with the social quality or value of our acts, and so nothing to do with morality. We are further told that more and more scientists are limiting themselves to what can be measured; that scientists are placing this limitation voluntarily upon themselves, and that science is naturally and necessarily what scientists say it is. This is the position of Dr. C. E. Ayres in his book, "Science the False Messiah." It is also the position of not a few philosophical and religious thinkers, who seem to find in this limitation of science the solution of many of their difficulties.

One obvious reply is that scientists themselves are divided. The "orthodox" scientists, as we may call them, would apparently limit the field of science to the measurement of objective conditions and the formulation of laws in such relations. They would not recognize the subjective or the world of values as within the field of science. Other scientists, however, do not hesitate to include such values, for example, as health and wealth within the scientific field. Indeed, the whole science of economics has been built upon the concept of economic values. Inasmuch as our social life is a life of values in all its phases, and is made possible only through the exchange of experiences between individuals, any study of it except in the most superficial terms necessarily must take the experiences and valuations of individuals into account. Thus far, in other words, the social sciences, whether they discuss markets, wars, governments, religions or other institutions, have been written in terms of human experience, and so in terms of value. It is for this reason that some, like Dr. Ayres, would deny the name of science to such studies, no matter how carefully they are made.

Here again we see the danger to clear thinking which may inhere in a word. The real question is, of course, not what meaning we should attach to the word science, but whether we can get tested, verifiable knowledge in the world of our subjective and social experiences, and so in the world of values. Hardly any one would say that we do not have tested and verifiable knowledge as regards health, though health is obviously a value; and he would be very rash who would say to an economist that we have no tested knowledge as yet regarding wealth and economic values. Moreover, this tested knowledge does not consist

always, or even in a majority of cases, of quantitative measurements. Quantitative measurements, indeed, are increasingly sought for by students in these fields; but they themselves would be the first to acknowledge that quantitative measurements in these fields are much desired because they are largely lacking, even though our knowledge of these fields in a general way is considerable.

Here questions as to scientific method naturally arise. What are the most fruitful methods of obtaining verifiable knowledge in the social sciences? Auguste Comte said that it was the historical method, but the historical method is obviously almost wholly devoid of quantitative measurements. Then there is the method of "the participant observer," which is one element in the historical method, and which can tell us so much about events and the behavior of groups, without again quantitative measurements. Then there is the method of the interview and the questionnaire, which can tell us so much about social behavior and its motives. Even the method of statistics, which aims at quantitative measurements of social phenomena, obviously depends upon the methods of the interview and of the eyewitness. If these latter methods are worthless from a scientific point of view, then so also the method of statistics. Our United States census, for example, is valueless if the method of the interview is not to be trusted, because the census largely is made up of the results of interviews. It is scarcely necessary to discuss the question of scientific methods further. These illustrations are sufficient to show that there are many ways of getting tested knowledge other than by the quantitative measurement of objective conditions, and other than by the methods employed in the physical sciences. The only question which remains is whether we should call such tested knowledge "science" or not.

This question concerns the whole future of science. The scientific movement seems to show the same tendencies shown by all other social movements in history. Every historical movement starts with some new enthusiasm, or hope, which reaches out in every direction and brings everything within the movement which may in any way serve its purpose. When the first enthusiasm is spent, the movement settles down into fixed habits which are supported by strong traditions. Gradually there grows up an orthodoxy regarding what the movement stands for, and, in order to hold their lines more securely, some leaders of the movement make the orthodoxy a very narrow one. This is evidently what occurred in the Christian movement, and we now see it being repeated in the scientific movement. Strangely enough, however, the orthodox scientists seem quite unaware that they are the victims of a hardening and a narrowing tradition. It is possible, of course, that the narrow interpretation of the scientific field for which they stand may prevail; that the scientists of the future will limit science strictly to the field of quantitative measurements. If they do so, then science can play a rôle only in the exact arts. I would not say that its rôle would be of decreasing importance, but it could have little bearing upon those deeper problems of life which concern qualities and values.

There is, however, good reason to hope that if the light of knowledge continues to increase in our world, narrow orthodoxies in both science and religion will in time disappear. Just as we have seen narrow orthodoxies in religion breaking up in our own day, so probably a not distant future will see the disappearance of tendencies to narrow orthodoxies in science. For men, if allowed to think freely, will see that the scientific spirit is the open-minded love of truth, and is quite independent of the straight-

jacket of any method. Moreover, they will see that if science does not take all verifiable knowledge for its field, then men will seek such knowledge elsewhere; for men can live in our complex world only by tested knowledge, and if science will not furnish it to them in the world of qualities and values, then some other instrument of culture will attempt to furnish it, and science will sink to second-rate importance in the guidance of life.

This is apparently exactly what some people desire; for they say that if science assumes first importance in the guidance of life it will exercise an unheard of tyranny over men. Let science confine itself to exact facts and relations, and let each individual evaluate these for himself. Let science keep out of the world of values, and let each individual, or group of individuals, decide values as it chooses. Only in this way, we are told, can we preserve freedom. But so far as science has assumed the guidance of life, it has thus far created no tyranny; and it is difficult to understand how it could do so if science identifies itself with tested knowledge. For knowledge makes truth evident, and truth makes men free. In the matter of health and disease, for example, science has not only discovered facts, but has evaluated conditions of living as regards health. No one has felt this as a tyranny, except possibly those who prefer to believe in ancient superstitions.

People have been told not to drink polluted water if they wish to avoid typhoid fever. But no one who wishes typhoid fever has been forbidden to drink polluted water. To be sure, the law, under the guidance of science, has forbidden people to give polluted water to others to drink; but this is fair, and not tyranny, because most people are guided by the values of common sense; that is, they prefer life to death and health to disease.

Now the case is exactly the same with the whole field of morals. The guidance of science in the field of conduct and of social relations could be resented as a tyranny only by those who prefer to be guided in their conduct by ancient superstitions and by unenlightened impulses and emotions. For tested knowledge, even when it concerns conduct values, places no external constraint upon the will; it only enlightens it. Nor is it true that science, if accepted as a guide of life, would stunt the growth of art, morals, politics and religion. On the contrary, when these are provided a scientific base through a critical analysis of human experience in these lines, we have good reason for believing that such scientific knowledge will aid greatly in the rational development of these phases of culture. Thus, for example, a science of religion will aid greatly in the rational development of religion. Such a science, by providing a knowledge basis for the development of religion, would in time come to be regarded as an indispensable part of religion, while at the same time it would remain a part of science. Thus the tree of knowledge might come in time to furnish nourishment to all the branches of culture which spring from its trunk. We can not agree, therefore, with Ayres that by trying to make our beliefs scientific we will make them absurd and powerless. Rather belief is too often powerless today because it is not in accord with tested knowledge.

Another historical parallel may be suggested here. Just as the Christian movement developed its narrow dogmatisms before it had reached its perfection, so the scientific movement shows similar tendencies. For, of course, our science is still very immature, and narrow views on the part of scientific men are often due to traditionalism and resistance to the process of growth. Hitherto our science has been mainly physical

science and there has been unwillingness on the part of the workers in the physical sciences to recognize the social sciences. This has led to the desire on the part of some workers in the social field to use only physical science methods and thus assert their right to be called "scientists." And such "scientists," as Bernard Shaw has said, often "actually regarded the banishment of mind from the universe as a glorious enlightenment and emancipation." Thus science ceased to be an all-sided movement toward knowledge of reality, and tended to become a narrow specialism linked with the machine and with the mechanical view of things.

Thus has come about largely the present plight of science and its present needless conflicts with other phases of culture. Science can escape from its present plight and from these conflicts only by becoming an open-minded movement towards knowledge of all reality and welcoming all methods which will assure such knowledge. But inasmuch as the most important part of reality for human beings is the human world, it is evident that if science thus broadens its scope, the physical sciences will fall to a place of secondary importance. Physical science can never be the guide of life, because it leaves culture largely out of account, and all the most important values of the human world are wrapped up in culture, yes, even in the non-material aspects of culture. A social science even which employs only the methods of physical science can not guide us, because it will miss the non-material aspects of culture and end in negations.

It is, of course, impossible to say whether or not the scientific movement will emancipate itself from the narrow dogmatisms which now threaten it. But if history involves a learning process which gradually corrects mistakes, this would seem probable. Then we could expect a development of the social sciences, largely in terms of history rather than in terms of mathematics and quantitative measurement. The sciences of culture rather than of physical nature would take the lead and have preeminence. Not only would each aspect of material culture have its supporting science, but also each aspect of non-material culture. Thus there would be pure sciences of government, of religion, of morals and even of fine art and of education, and supporting all would be sciences of human relations, of human group life and of culture itself. These studies would be recognized as having the same scientific validity as the sciences of physical nature.

It may seem to some that we have already reached this stage, or, at least, that it is immediately in the future. We may, of course, hope that this is true; but the strong movement in the scientific world to limit science to the external and the quantitative, as well as the strong movement in art, in politics, in morals and in religion to deny any dependency upon science, should warn us that the social sciences are still far from established. Only one of the non-material phases of culture definitely looks to science for guidance, and that is education, and it has not done so until recently.

Yet the great need of our present civilization is to develop as quickly as possible the non-material, or spiritual, phases of culture, especially government and law, education, morality and religion. The only possible way to develop these phases of culture is to accumulate and diffuse as much tested knowledge concerning them as possible. Naturally such knowledge will concern, among other things, the social function of each of these great phases of culture, and will seek to show how each of their historical forms functions in given social circumstances.

The opponent of science having anything to do with the practical problems of our world will probably at this point hold up his hands with holy horror, and

exclaim: "What! science indicate the relative social values in democracy and autocracy, sovietism and Fascism, hedonism and intuitionism, Confucianism and Buddhism, Mohammedanism and Christianity! Why, that would make science a partisan affair, and win for science only the enmity of the partisans of these systems." The reply is that science can not attain to a true non-partisanship by remaining aloof from all questions which have partisans. If it did, it would remain aloof from all vital social questions, because it is a constant characteristic of vital questions that they have partisans. If science is going to remain aloof from all questions of politics, of morals and religion, then it can not function as a guide in life, to say nothing of being helpful in the development of these phases of our culture. Even such a general science as sociology will be a useless and "dead" science if it can contribute nothing to the solution of the political, moral and religious problems of human society. If Fascism and sovietism, democracy and autocracy, can not be socially evaluated upon the basis of established social knowledge, how will these problems of governmental forms be solved? It is as cowardly for the social scientist to refuse to deal with such vital questions of human welfare with the best scientific methods available as it would be for the medical or biological scientist to refuse to deal with a pestilence.

If tested knowledge is to benefit man, and if science may be identified with tested knowledge, then the great field for science in the future will be human relations. The tasks of physical science are, of course, far from completion, and the urgent needs of men in the way of food, power and physical health will probably put large demands on the physical sciences in the near future. Still the demands of social life with its increasing complexities and difficulties are even more urgent. One can not visit Europe and witness its overpopulation, the poverty and ignorance of its masses, its international and interracial hatreds and antagonisms, without realizing that if scientific knowledge can not help in the solution of these problems, the outlook is indeed dark. And I am forced to add that I could discover little or no evidence in most of the countries of Europe of the leadership of the social sciences in the solution of these problems. Science is still far from a dominating element in the life of most of these peoples. When we turn to the United States we find the situation changed, but not essentially different. We have more completely absorbed the results of the physical sciences, and created a machine civilization. But the social ignorance, the poverty, the lawlessness, intolerance and antagonism of our masses and classes persist, and become all the more dangerous because we have a machine civilization. The very advance of physical science, as Professor Soddy declares, has become a menace to our civilization if our present low social standards persist. We must have more social intelligence, more tested social knowledge and more agreement regarding social problems if our civilization is going to have even a chance of developing in a satisfactory way.

It is pathetic under such circumstances to find the leaders in the human sciences just at present apparently hopelessly divided among themselves. There are a full half dozen different kinds of psychology to-day each claiming scientific standing, and each hostile to all the other kinds; and the same condition exists in sociology. Our scientific world to-day is as badly divided as our religious, political and social. But it could hardly be otherwise; for these divisions are but indications that the method of development in our human world is the trial and error method. These divisions do not indicate the failure or the "bankruptcy" of science, as its critics so often

proclaim; they may rather be signs of growth. In part the divisions are due to one-sidedness in viewing reality, to the fact that each faction in science, quite like each sect in the religious world, sees but a part of the truth; but even more are these divisions due to the different methods and assumptions which different students of human behavior employ. Scientists in general seem surprisingly ignorant of the fact that science usually develops through trial and error. Especially do the advocates of the latest method or the latest theory in some science seem painfully ignorant of this fact; for they advocate these with all the fervor of converts to a new religion. They are certain that they are right, whereas most of us only see reason to lament that the scientific movement is made the victim of fads and fashions. But if our European mind is too dogmatic to rise above these fads of the hour to a true synthesis, if we are unable to see reality and see it whole, we may be sure not only that the scepter of knowledge will pass from us, but that some other race than ours will in time learn from our mistakes.

The great development of science in the future must be, therefore, in the humanistic direction. This trend is in evidence even in the physical sciences. The human sciences themselves will more and more come to center their attention upon the distinctively human, as the basis for man's further progress and development. Culture, in all its aspects, as we have already indicated, will become the center of scientific attention, and the subject-matter of a group of sciences, the sciences of culture, which will repudiate the method of the physical sciences, the method of weighing and measuring, as adequate for their purposes. Among the phases of culture, the non-material, or "spiritual," are the most distinctively human; therefore, they will receive the special attention of humanistic science, and the group of social sciences concerned with these non-material phases of culture will be held to be most important to humanity.

Now in these non-material phases of culture and in human relations generally the great need is a set of standards which will enable us to judge and control conduct to human social advantage. The sciences of the non-material phases of culture will, therefore, become the basis of a set of social sciences concerned with standardization. The work of sciences of standardization in the physical field, or more strictly in the field of material culture, is already far advanced. But as we have seen, there are still many who deny that we can have sciences of standards in such fields of human conduct as government, morals and religion; and that if we did have them, we would have an intolerable tyranny. It is impossible, however, to see how mankind can ultimately avoid the determination of standards upon the basis of tested knowledge in these fields. We doubtless should leave a large freedom to the individual. But this principle does not prevent the scientific determination of standards. In at least two of the non-material phases of culture the scientific determination of standards is already far advanced. I refer to education and social work. In both these fields the testing of experience, the sifting of facts and generalizations from these have led to the establishment of many helpful standards, even though we may concede that the work is as yet only begun. In charitable or philanthropic work, which is one of the most delicate and difficult of all human relations, the same procedure has resulted in well-established scientific standards. Nobody, it may be remarked, has found any tyranny in establishing standards in these lines of conduct except the few who wish to act upon impulse, or old habits.

In a word, if science becomes once thoroughly humanistic, the whole field of relative standards, values and ideals in human relations will become objects of scientific determination. The social

sciences will expand in their normative and applied aspects. Why any one even now should dread this development is hard to see. If social standards, values and ideals are not based upon tested knowledge, they will be based upon things quite untrustworthy. If on the other hand humanity can secure standards based upon tested knowledge in government, in morals, in religion and in education, and can secure the general acceptance of these through education, then progress in civilization will enter upon a new phase, the telic phase which Lester F. Ward predicted. And there is good reason to believe that even the most perplexing problems of our civilization would soon be on the way to solution. Every phase of culture, nonmaterial as well as material, would soon be headed toward the best development for the weal of man.

Whether our age or our race will or will not carry through this broadening of the field of science which we have described it is impossible to predict. But it would seem certain that if history involves an accumulation of experience, such a broadening of what is generally recognized as tested knowledge is certain to take place. Whether it will be called science or not, is, of course, a matter of indifference. The important thing is that science in the name of its purity or orthodoxy do not put a ban upon the accumulation of such tested knowledge. Ample and accurate information, a great financier has said, is the foundation of success in the business world. We have every reason to believe that it is the foundation of success for nations and civilizations as well as for individuals. If science is unwilling to have the ample and accurate information necessary for successful human living sought, accumulated and diffused under its name, then it will have to be done under some other name.

If, on the other hand, science identifies itself with the whole field of tested knowledge, then its function with reference to other phases of culture will become clear. The conflicts of science with these other phases will disappear. I have ventured to say elsewhere that between a humanistic science and a humanitarian religion there can be no conflict. Certainly there could be no serious conflict. For between the tested knowledge regarding human welfare presented by such science and a religion which finds its expression in the service of mankind a natural and inevitable interdependence would arise. So, too, with a humanitarian ethics and a humanistic philosophy. A bridge of thoughts and values would grow up easily and naturally between science, morals, philosophy and religion. Science, both as a knowledge of facts and a knowledge of practical values, would point clearly to standards of rational social conduct. But beyond the tested knowledge of facts and values of science would lie the ultimate problems of knowledge and of reality. This, I take it, would be the field of philosophy; and a philosophy which built itself upon total tested and verifiable human experience would be strong, not weak. It would be another bridge between science and religion. To religion then would belong our ultimate values. It would be our valuation of our universe, or as Caird said, "the summed-up meaning and purport of our whole consciousness of things"; and if based upon tested and verifiable human experience, it could naturally have but little conflict with a science similarly based. The conflicts which we now find so commonly in the minds of individuals between their scientific knowledge, their ethical ideals, their philosophical beliefs and their religious faith would disappear; for there would be no arbitrary separations made between these; and they would be seen to form a natural series, which when its parts are logically interconnected, forms also a harmonious whole. Thus science and religion would become one in spirit and in aim.

THE SPLEEN

By Dr. WILLIAM DeP. INLOW

If the spleen swells, it is painful, and besides, it creates profuse laughter; but it is asserted, that the cutting of it out, cures that immoderate passion.

—*Serenus Sammonicus*

THE spleen is an organ of mystery. To ancient and modern alike he has been an object of the most active curiosity. The hypotheses which have been indulged on his nature are beyond measure numerous and visionary. He has been considered "the seat of the soul; the organ of dreaming, of melancholy and of laughter, of sleep and the venereal appetite"; a viscus that secretes the mucilaginous fluids of the joints; a bedfellow who cuddles the stomach and keeps it warm; or indeed, a mere stuffing to fill a hollow or vacuum. He has been thought about by philosopher and poet, physician and scientist, yet to-day he remains largely unknown.

The spleen is a sleek, glistening, contractile body hidden modestly in the upper left abdomen under the margin of the ribs, snuggled in between stomach and kidney, colon and diaphragm. He weighs about six ounces. His shape is described variously by the anatomists as ovoid, ellipsoid, tetrahedral. He looks like a pebble in birds, like a Y in marsupials and monotremes. In many animals he has strange notches and fissures, and in the porbeagle shark he is hundred lobed. He occurs only in vertebrates.

Who has not been served from the stuffed belly of a fowl a mottled purple pellet the size of the heart, the luster lost in the cooking? It was the spleen. In man at birth his color is a *beau rouge;* this tint accentuates itself little by little in the first years, then pales in old age till it becomes a *gris sale.* Cherry red in youth, bluish red in middle age, the milt in the senile appears dark blue like the blood shining through the veins on the back of the hand.

Of what use is this structure? He has an artery leading to him so big for such a small organ; he does not stay quiet, but contracts rhythmically; he does not remain one size, but swells at the height of digestion; his blood flows back through the enormous liver; he is made up of lymphoid tissue somewhat like the lymph glands; he has been cut out with impunity. Shall we believe the philosophers, the scientists or the poets? Indeed, it seems that we can cull as little knowledge from one as from another. We shall have to dig deep for a few brilliants, and thumb many manuscripts of no interest; it will be only human if we become beguiled by the excursions of fancy. Instead of splenic facts we find only phantasies to clutter the highways of sober thinking. We shall listen first to the voice of history, then to that of the experimentalists and lastly to that of the poets.

I

An idle member and good for nothing.

—*Russus Ephesius*

The opinion that the spleen is unnecessary and of no use to the individual has prevailed with an uninterrupted succession in the world in all ages from the oldest antiquity. In Persia so many centuries ago as the reign of Abauserus it was a custom to eviscerate the milt from horses that were kept to carry the king's dispatches, in order to give them more agility and swifter feet. The great Aristotle thought the spleen to be no more than a spurious liver planted in the left side to answer that in the right, that, a balance thus preserved, neither side

might preponderate. He affirmed that the spleen is necessary by accident to those that have him, even as the excrements of the belly and the bladder. Plato calls the spleen a collection or heap of impurities, purgations and offscourings.

Great numbers of the ancients, being persuaded that the spleen was not only superfluous and impertinent but likewise detrimental and mischievous, thought it very desirable that their patients be freed from such a noxious companion, and therefore applied their industry to find out effectual ways and means to extirpate and destroy him; and this they attempted by internal medicines and external applications and by manual operations. Among the medicines especially prescribed was scolopendria or asplenium. The discovery of this drug is related by Vitruvius, who, speaking of a certain river between Gnossos and Cortyna in Crete, says that the cattle that feed near Gnossos have a large spleen, but that in those that feed on the other side near Cortyna the organ is scarcely discernible. Physicians inquired into this matter and found in these places an herb, which when eaten by the cattle greatly diminished their spleens; then gathering this plant they prescribed it and called it asplenium, that is, consumer of the spleen. The method of operative removal employed consisted in raising the skin incumbent on the spleen by means of a hook and then burning this through by an oblong red-hot iron.

William Stukeley in the beginning of the eighteenth century not only considered the spleen a reservoir for blood, a sponge as it were to soak up the excess and later give it out as needed during digestion, but also advanced the opinion that this organ by his proximity, great vascularity and timely congestion furnishes heat to the stomach. He maintained that nature proclaimed the great eminence of the spleen by his situation on the left side where digestion is chiefly performed, closing the stomach up like the door of a furnace that it might have an equable warmth all around. He further adduced as proof of this assumption the notorious and terrible effects produced by eating ice in hot countries!

Patrick Black, of the hospital of St. Bartholomew, in a fanciful skit on the spleen's marriage wonders if it is not a matter of considerable importance that the milt empties his blood back through the liver. He emphasizes this by an illustration.

> Think of our court of Aldermen sitting down to dinner at the Mansion House. They begin with turtle and iced punch; this is followed by a dinner of six courses, with wines "still" and "sparkling," every five minutes, for the space of about two hours; the whole is concluded with copious libations of port wine. Is it of no consequence whether these gentlemen take their spleens with them to the banquet or not? In your own case, physicians in high practice and professors of physiology, would you entrust your portal system to take so much of this rich material direct to your Liver, before it was well watered by your Spleens? I trow not.

Finally, must we not crave leave to do justice to an eminent divine and to Isidore, who do more than assert the usefulness of the spleen, for they plead for the necessity of him to prevent a vacuum; for that they say, must have been the sad consequence had not that place in the left side been filled up by the spleen. And then how dreadful a condition had the world been in!

II

The spleen has been excised in animals thousands of times in order to try to determine his significance in the animal economy. Alas, the disturbances occasioned by his absence have been slight. Modern splenectomists have been but little more successful than their predecessors.

There has been no want of high ability, no absence of ripe knowledge, but withal no guiding idea. A few philosophers have met together, and made the following arrangements. One is to bring his lens or microscope; the chemist his bottles and test-tubes; the pure anatomist his injecting pipes and fine instruments; may I add to these the vivisector with his rabbits from Leadenhall Market? They meet and confer. "It will be hard indeed," they say, "if we don't strike out something amongst us." Yet, with all this fine ability, these great resources, and high promise, they have to bear this hardship—they stumble upon nothing; their work, though varied and ingenious, has been infructuous; they conclusively establish many negations, and they record them all in a report, which, though deemed a model of philosophic inquiry, is one, nevertheless, in which they have only to inform the world where they have not found the object of their research.

Malphigi, the eminent Italian anatomist, was the first to endeavor experimentally to solve the riddle of the spleen. Assisted by two ingenious friends he opened the side of a young dog and bound the blood vessels at the entrance of the spleen with a strict ligature. The dog not only survived the operation, but performed with alacrity his natural functions without any mark of impaired health. After a space of time Malphigi opened the dog again and found the organ shriveled and shrunk to the minutest size, looking like a dried-up hull. He did not find the use of the spleen; yet, had he reflected, he might easily have found out, as wittily remarks a sage commentator, that this bowel was of no use at all!

Among the earlier splenectomists was the later renowned French surgeon, Dupuytren, at that time a rising professor of the École Pratique. "We may suppose some of his youthful companions thus addressing—'Dupuytren, a quoi sert la rate?' He would shrug his shoulders, *more Gallico*, the meaning of which we all know, and would add, 'Cut it out and watch the result.'" This they did and repeated it even to the fortieth time. Those animals that recovered began to show, about the third week, some symptoms of returning appetite which was designated as a state of "remarkable voracity." This, however, was all the philosophy cut out of those forty dogs.

Henry Gray, the well-known English anatomist, worked assiduously on the spleen. His dissertation won the Sir Astley Cooper prize in 1854. He dissected great numbers of all sorts of beings from eels to lions; he experimented on London cab horses and on donkeys. It is chiefly the present novelty of his experimental animals that seems remarkable.

Among the moderns it is probably our own W. J. Mayo who has removed more human spleens than any one else. To him the spleen is a sieve, a strainer which removes from the blood bacteria and protozoa, poisonous products and worn-out blood corpuscles. Indeed, the study of disease in the human has given more insight into the problem of the spleen than anything else.

Even among the earlier physiologists deducing their results from their splenectomies we find at times ideas almost as fantastic as those we have just gleaned from the philosophers. Thus certain enterprising experimenters have observed after removal of the spleen: diminished fecundity, frequent choking and vomiting after a hearty meal, increased liability to watery effusion into the serous cavities and favoring of the assimilation of fat!

But what is it that the modern scientists know and believe concerning the spleen? He gives rise to red corpuscles during fetal life and shortly after birth, and in some animals throughout life. He is supposed to be an organ for the destruction of red corpuscles. He takes part in some way in the processes of immunity. The physician sees him enlarged and affected secondarily in many

diseases, while his primary and peculiar diseases are rare. The surgeon removes him occasionally for rupture from injury, and as a curative procedure in some of his primary affections. All are looking forward to an understanding of his full significance.

III

Nature has formed me of satiric mould,
And spleen too petulant to be controlled.
—*Persius*

Who indeed cares about the spleen, or would take the trouble to listen to anything that might be said on the subject? Has he not been cut out of the body hundreds of times after the most approved method of settling physiological questions? Has he not as frequently been proved to be utterly useless or superfluous? Why then bring his dead carcass out of that tomb of physiological oblivion to which he has been so long and so justly consigned? Let him live, if indeed he be allowed to live, to please the fancy of the poets, for whom alone he seems to have been created. Surely they will gladly take him over from the willing hands of the philosophers, and be merry over his true function which they alone have had the good fortune to discover.

We shall listen first to a poetess, the Countess of Winchilsea, writing a Pindaric ode over two centuries ago.

So Protean as his form, so infinite seem the moods at the spleen's beckoning. The surging of surfs, the happy gurgling of freshets lie hidden in the calm dead of his waters. He is father of the wraths of peasants, the passions of courtesans, the melancholic broodings of lovers disconsolate. Monks pray, friends listen in groves to low-toned contumely, battles lose themselves at his mandate. Who does not know of the monstrous vision of Brutus before Philippi; who has not at midnight seen pointed fires and specters dance? They say it is the spleen that gives the lure of the cup, the inanity of garrulity, the excuse of foppishness. Untamed from drinks of the Orient, unsoothed by the lull of indolent music, it is ever his wont to break forth in peals of acidulous laughter.

When the coquette, whom every fool admires,
Would in variety be fair,
And changing hastily the scene
From light, impertinent and vain,
Assumes a soft, a melancholy air:
And of her eyes rebates the wand'ring fires,
The careless posture and the head reclin'd,
The thoughtful and composed face,
Proclaiming the withdrawn, the absent mind,
Allows the fop more liberty to gaze,
Who gently for the tender cause enquires,
The cause indeed is a defect in sense,
Yet is the spleen alleg'd, and still the dull pretence.

The sullen husband feigns his spleen when he spends his ill humor with his wife. So it is with all gross abuses. The imperious wife herself is not immune. Overheated passions rise in crowds to the attractive brain, overcast and showering eyes play upon the spouse's softened heart; he yields the disputed point. Mistaken votaries to the powers divine restrained from speech and banished to deserts or reclused in cells but obey the spleen and worship at his shrine. Thus religion suffers from the dire effects of the more powerful charms; religion that should enlighten all here below is veiled in darkness and perplexed with anxious doubts, vexed with endless scruples and some restraint implied from each perverted text. Touch not, taste not what is freely given is but the niggard voice of the spleen disgracing bounteous heaven.

The fool to imitate the wits
Complains of thy pretended fits,
And dullness born with him would lay
Upon thy accidental sway;
Because sometimes thou do'st presume
Into the ablest heads to come.

No sweets till the reign of the spleen could shock the sense or bring to the face a flushed unhandsome color. Now the jonquil overcomes the feeble brain, and we faint till some offensive scent placates

the powers of the spleen and we resign pleasure for short and nauseous ease. Through the spleen's black jaundice which overtakes us we see all objects as dark and terrible as the mysterious organ himself. We use all means to free ourselves from his spell, all arts, all remedies—we quaff infusion of the Indian leaf, bruise the parched eastern berry—all is of no avail. We seek to chase this strange malady with the gentle strains of many melodies; thus do we hope to divert the murkiness of his stream of icteric influence. We inspire the flute and touch the string in vain; no help is had from harmony—music if too sweetly sad but soothes him, and if too light but turns him gaily mad.

The son of Bacchus pleads thy power,
As to the glass he still repairs;
Pretends but to remove thy cares,
Snatch from thy shades one gay and smiling hour,
And drown thy kingdom in a purple shower.

Poesy thus ascribes to this organ as many and diverse functions as do philosophy and science; furthermore these functions are just as contradictory, or more so. While the scientist sees the spleen in the double capacity of both a creator and a destroyer of red corpuscles, a being like the mythic Saturn, who devoured his own children, the poet sees him both as the organ of mirth and laughter and of sadness and melancholy. Probably the primary interpretation was that of mirth.

Such fantastic tricks
As make the angels weep; who, with our spleens,
Would all themselves laugh mortal.
—*Shakespeare*, "Measure for Measure"

The interpretation of melancholy is associated with the ancient conception of the spleen as the seat of black bile. It is illustrated in the modern German word for hypochondriasis, *Milzsucht*.

Tempelherr: Wozu?
Ich habe Fleisch wohl lange nicht gegessen;
Allein was tut's? Die Datteln sind ja reif.

Klosterbruder:
Nehm' sich der Herr in Acht mit dieser Frucht.
Zu viel genossen taugt sie nicht, verstopft
Die Milz: macht melancholisches Geblüt.
—*Lessing*, "Nathan der Weise"

Yet another interpretation used by the poets is that of anger, probably an innovation on the original meaning.

and at the last he sware
That he would send a hundred thousand men,
And bring her in a whirlwind; then he chewed
The thrice turned cud of wroth, and cook'd his spleen,
Communing with his captains of the war.
—*Tennyson*, "Princess"

This organ excised for the swiftness of horses by Persians, dwindled to nothingness in kine by the feeding on pastures of Cretans, heavy with foul liquors drawn off the livers of Greeks and of Romans, made famous by the Italian Malphigi, is thus seen to be a creature of caprice and of many moods, created apparently to subserve the fancy of the poets. For to the modern physician even as to the great Galen of the past the spleen remains *mysterii pleni organon*.

THE IMPORTANCE OF NUTRITION IN CHILD HYGIENE

By Dr. VICTOR E. LEVINE

DEPARTMENT OF BIOLOGICAL CHEMISTRY AND NUTRITION, SCHOOL OF MEDICINE, CREIGHTON UNIVERSITY

NUTRITION has come to be looked upon in the last few years as a very important factor in the life of the individual. The spirited public-health worker realizes the importance of diet for maintaining health, and the progressive physician is now effectively employing diet as a therapeutic measure.

In a great nation it is very desirable for its citizens to use all the known means of science to keep physically fit. It may be surprising to many of us to realize the extent of ill health in our own country. The report of 1918 of the Department of Labor, Children's Bureau, Washington, D. C., presents figures that should awaken even the most indifferent citizen. There were in 1918 approximately twenty-two million school children. At least 1 per cent., or 200,000, ranked among the mental defectives. At least 1 per cent., or 200,000, were handicapped by organic heart disease. At least 5 per cent., or one million, were on the verge of having tuberculosis. At least 25 per cent., or five million, had defective vision. From 15 to 25 per cent., or three to five million, had diseased tonsils and other glandular troubles. From 10 to 20 per cent., or eleven to sixteen million, had defective teeth. At least 20 per cent., or four million, were suffering directly from malnutrition. At present one third of Chicago school children have some nervous disorder, and two thirds of New York school children are physically defective.

A large percentage of growing children are underweight for their height. Judged by standard height-weight tables, from 15 to 40 per cent., and even as high as 60 per cent., of school children have been found to be undernourished. In a study of 506 children selected as the best specimens of health that could be found among school children, it was found that one fifth of them were underweight according to the standards most frequently used in school work in the United States. Twenty per cent. of these children were more than 10 per cent. underweight according to Wood's standard height-weight-age tables; 13 per cent. were more than 10 per cent. underweight according to Dryer's standard stem length and chest circumference tables.

Undernourishment and malnutrition have been found to be prevalent among the children of the well-to-do as well as of the poor. To remedy this condition requires individual diagnosis of the cause in each instance, and success often depends upon the cooperation of the parent, the teacher, the physician and the child.

Over a billion dollars is spent each year by our nation for the education of the pupils in the schools, but only twelve to fifteen million dollars is expended for school health work. Only sixty-five cents per child per year is spent on health, that is less than 1.5 per cent. of the total school fund. No wonder that 15 to 20 per cent. of nonpromotion, retardation in studies and elimination of children from school is the result of ill health and the neglect of remediable defects. No wonder that

approximately two hundred thousand children die each year, 130,000 of these coming from the public schools.

The physical imperfections in the children of our land reflect the physical condition of our adult population. Our first national health inventory came through the World War, when about five million men between twenty-one and thirty-one years of age were examined as to their physical fitness for military duty. The records of the War Department proved most convincingly that a large per cent.—about 30 per cent.—of our young men could not serve their country by reason of physical unfitness. At this rate we may state that about twenty-five million young people in the United States are below par and in need of more or less immediate medical attention.

Some authorities claim that out of the present population of 110,000,000, only 19,500,000 are in full vigor, 37,500,000 are in fair health, while 45,000,000, or about one half of the population, are more or less physically imperfect. All the time in the United States there are three million people seriously ill, and every year we have about one and one half million deaths, by far the greatest number of which are needless and premature. For every death there is an average sickness of two years, or for each death per year there are two persons sick throughout the year.

In the past several decades there has been a steady gain in vitality in the younger age groups. This gain, unfortunately, has served to mask a loss in vitality at the older age periods. This latter phenomenon, a rising mortality in elderly life, is not exhibited in the mortality statistics of European countries. It is almost exclusively peculiar to the United States. The cause of the increase in morbidity and mortality in the later decades of life is due to the increase in the so-called wear-and-tear diseases, the degenerative diseases, the harvest reaped from unhygienic habit disorders. About half a million people die each year from degenerative diseases, heart disease, arteriosclerosis, hypertension, cerebral hemorrhage, diseases of the kidney, diabetes and diseases of the liver. The only group of diseases which can compare with this frightful loss is the respiratory group, which includes pulmonary tuberculosis, pneumonia, influenza and bronchitis. About 65,000 people die annually in this country as a result of degenerative diseases before they reach the age of fifty, and about 30,000 before they reach forty.

Health, our greatest national resource, we squander recklessly. The American people are indifferent to personal and community health problems. They have not yet taken up the conservation of health and the prevention of disease with the same enthusiasm and wholeheartedness with which they carry on their industrial and commercial enterprises. It is strange but true that year by year the human being tends towards omnipotence over the forces of nature, remaining an irrational primitive only in the lack of command over himself. We are occupied largely in treating symptoms, not in fighting disease; in dealing with the results of ill health, not with the keeping of good health. During the World War, a period that consumed less than five years, over seven million persons were killed. Those of us who read this figure with grief and sorrow in our hearts fail to realize that the horrors of peace exceed those of war. Not less than seventeen million lives throughout the world are lost each year as a result of preventable disease.

The general lack of good health, which we have briefly touched upon, is revealed, moreover, in a highly successful and prosperous country possessing an

enviable climate, and in spite of the great advances we have made in hygiene and sanitation. Wherein lies the cause of this widespread physical deterioration?

Among the factors figuring prominently in the causation of degenerative diseases are: (1) the habitual use of drugs (alcohol, tobacco, patent medicines, laxatives, headache powders); (2) venereal diseases; (3) deficient elimination; (4) a negative mental attitude—chronic fear, worry, mental unrest, anxiety, inferiority complexes, fits of temper; (5) minor chronic infections, which are usually neglected; (6) remoteness from nature—lack of sunshine, lack of fresh air, indoor life and lack of exercise; (7) strenuous living—with its many hours of fatiguing concentration and too few hours of relaxation, and (8) nutritional errors.

McCollum, of the Johns Hopkins University, has spent many years as an investigator in the field of nutrition. As a result of intensive research this brilliant man has enriched his chosen field with many fundamental facts and underlying principles. He has been, indeed, very instrumental in raising nutrition to the dignity of a science. His work does not end with the laboratory. He has gone one step farther. Through his books, his public lectures, his students, his contacts with groups organized for social, civic or hygienic improvement, he has finally succeeded in democratizing and socializing this knowledge of nutrition. Listen to him for a moment for the explanation of the present state of lack of physical well-being in our country:

> If one examines the writings of those of to-day who are most active in studying the health problem of children and in arousing the nation to activity in their behalf, one finds various causes assigned for existing conditions. All would agree that we must attribute our physical deterioration to subjection of the human race to new and unfavorable conditions, but differences of opinion exist as to the nature and relative importance of these. The sedentary life within houses instead of out-of-doors, the wearing of clothing instead of exposing the skin to the weather with its changing conditions; the eating of soft, cooked food instead of raw, coarse food; the debilitating effects of certain climates, the preservation of weaklings through improved hygiene and care, the artificial feeding of infants instead of nursing, the burden of responsibilities of civilized life, both mental and moral, and the failure to care for the hygiene of the mouth are among the causes most important. Doubtless each of these plays its part in contributing to place civilized man in many parts of the world in his present unenviable position with respect to health. It can now, however, be asserted with assurance that the chief factor responsible for human deterioration in recent times is not included in the above list. *The chief factor lies in the unwise choice of food.*

We have spent a good deal of money and effort in the breeding of stock. We should pay much greater attention to the raising of the human being. For failing to do so Rose Trumbell rightly rebukes us in her powerful poem:

THE BREED OF MEN

You talk of your breed of cattle
And plan for a higher strain,
You double the food of the pasture,
You heap up the measure of grain;
You draw on the wits of the nation
To better the barn and the pen,
But what are you doing, my brother,
To better the breed of men?

You talk of your roan-colored filly,
Your heifer so shapely and sleek,
No place shall be filled in your stanchions
By stock that's unworthy and weak.
But what of the stock of your household,
Have they wandered beyond your ken
Or what is revealed in the round-up,
That brands the daughters of men?

And what of your boy? Have you measured
His need for a growing year?
Does your mark of his sire on his features
Mean less than your brand on a steer?
Thoroughbred—that is your watchword
For stable and pasture and pen,
But what is the word for the homestead?
Answer, you breeder of men!

The great part that improper nutrition plays in the causation of disease is realized more fully when we consider the vast biologic damage faulty food can inflict upon the young as well as upon the adult. Malnutrition leads to greater susceptibility to infection. The frequent cold or sore throat, the infected sinus, the infected tonsil, the middle ear infection, bronchitis or tuberculosis is apt to strike readily the malnourished individual. The death-rate from acute respiratory disease is exceedingly high in children under five years of age, a period when malnutrition occurs frequently and with great disaster.

Malnutrition leads to disturbances in the development of bone and teeth. Poor teeth, soft chalky teeth, carious teeth, missing teeth and infected gums are indications of improper feeding. Scurvy, rickets and other diseases caused by faulty food destroy very early the integrity and health of dental structures. Mechanical brushing of the teeth is an external method for personal cleanliness and beauty. Hardness or softness of food or mastication has very little to do with keeping teeth in a healthful condition. For sound teeth and gums we need a well-balanced diet.

Malnutrition leads to symptoms referable to the gastro-intestinal tract, such as distress after eating, a feeling of fulness and pressure, abdominal pain, gastric anacidity, hypoacidity or hyperacidity, gastric or duodenal ulcer, diarrhea and constipation. It has been estimated that 50 per cent. of the American public is constipated, and that this vast army of constipated bipeds consumes annually laxatives to the amount of fifty million dollars.

Malnutrition leads to stunting in growth, to underweight or to overweight, to moderate or severe anemia, to muscular weakness and general debility, to faulty posture and to fatigue. Improper diet may bring about injury to the kidney and to the heart muscle.

Malnutrition injures the glands of internal secretion, glands which furnish the biologic urge or drive of the individual. Malnutrition produces marked changes in the nervous system anatomically and physiologically. Malnutrition spares nothing, for even the emotional and mental life of the individual may suffer. An ill-fed individual is apt to be irritable, melancholy, languid, apathetic, lacking in determination, in ambition and in the power of concentration.

We are beginning a new era in the history of the human race. Our past civilization has been built upon institutions, governments, great industries, great commercial enterprises, great highways, great cities. This type of civilization, the sun of which is now setting, holds as its goal impersonal perfection. The newer type of civilization, the sun of which is now rising, takes as its goal the perfection of the human being, who is after all the controlling force that dominates any institution or institutions. This newer aspect of civilization really leads us into humanization. It has developed for us the social sciences, sociology, economics and psychology, preventive medicine and hygiene. It has crystallized for us the ideal of social service. This newer aspect of civilization heeds the prophetic voice of the coming age and aims to correct the errors of the past.

It was Edwin Markham who was one of the first to see clearly the trends of the new spirit. In his poetic way he protests against the old order of things and makes demands for the new:

> We are all blind until we see
> That, in the human plan
> Nothing is worth the making, if
> It does not make the man;

Why build these cities glorious
If man unbuilded goes?
In vain we build the world
Unless the builder also grows.

Year by year we begin to realize more and more fully that the strength of humanity lies in the individual and that the chain can not be made stronger than its weakest link. We begin to comprehend more deeply the importance of the fact that the unit of society is the individual and that whatever brings out the best in the individual is a gain for society as a whole. Our educational ideals have changed to harmonize with this concept of social philosophy. The aim of education is no longer to make a gentleman or a lady. Its aim is not, as some would have us believe, to develop an individual capable of gaining a livelihood. Its aim is much higher. Its supreme goal is the development of the individual in all his potentialities, physical, mental and spiritual. In short, modern education holds out as its product the man or woman with an all-rounded personality, armed with health and vision and knowledge, prepared to carry on in a world full of complexities, competition and rivalries.

Happiness is an inward adjustment, but it depends to a large degree upon external factors. Among these factors we may mention health. Loss of health is the greatest obstacle to happiness and activity. It mars the personality. It cramps its possibilities. It limits its usefulness.

Health is not a gift given freely. A positive mental attitude is required to hold this priceless treasure. A knowledge of the simple laws of hygiene and sanitary living is indispensable. A conversion of this knowledge into correct life-lasting hygienic habits is absolutely necessary. As Huxley has stated, the aim of education is not knowledge but action.

Man as he reaches maturity unfortunately loses the flexibility of youth. He becomes an unyielding bundle of habits not subject to great correction or change. To attempt to modify habits of life in the average adult man or woman is almost a useless task and a thankless job. On the other hand, youth is plastic, receptive, acquisitive. The boys and girls in the care of the parent and the teacher are rough stones direct from the quarry, ready to be fashioned into beautiful living monuments.

Among other things, the parents and the teacher can lay the foundation for a sound mind in a beautiful, healthy body. They can reveal an interest, keen and enthusiastic, in personal hygiene. They can build in through the dispensation of knowledge and through their own daily practices the habits that lead to a healthful life, and they can destroy that cankering sore, malnutrition, which undermines the health of the boy and the girl, and which may prove to be the basis of much of the disease processes that rob them in later days of the good things of life, nay even of life itself!

We in this great country of ours are apt to lay great stress on some things and underemphasize others. We brag about our material prosperity and about the twenty-five million automobiles we own. You remember the story of the famous Roman lady, who boasted to her guest of her priceless jewels. When requested to show them, she immediately brought forth her two lovely children and proudly proclaimed that these were her priceless jewels. With the same pride as that shown by Cornelia, we should point to the immense wealth and treasure represented by our thirty-five million children. In the words of Phillips Brooks, "The future of the race marches forward on the feet of little children."

To the parent and to the teacher, each and every one of these millions of children speaks and says in his own way:

I am the captain of industry of the next generation, the creator of things ugly or beautiful, the saint or the criminal, the man or woman of action and energy, or the man or woman of sloth and indolence.

I hold in my hand the future of civilization. I can destroy the sweet fruits of the labors of the past, or I can plant the seed of even greater happiness than now exists.

In short, what I am to-day or what I shall be to-morrow, depends much on you.

I am the question to which you make reply.

We are living in an interesting period of transition. Life is becoming more intricate and more complex, while at the same time the hours of leisure are increasing, and the joys of life, physical, mental and spiritual, are multiplying rapidly. The school, reflecting as it should the life of the times, has also increased its activities in many directions. It has enlarged its scope, and it has even been forced to invade the field of that teaching formerly the province of the home.

In order that the child may successfully cope in later life with the ever-increasing demands upon its vitality which modern living necessitates, we have begun to incorporate into the curriculum the art and science of healthful living.

We have made much progress in preventive medicine. We have conquered many infectious diseases, like smallpox, diphtheria, measles and scarlet fever. We have almost slain the monster of infection. But a new monster even more ferocious and destructive has arisen in our midst. This new monster is represented by the degenerative diseases, the wear-and-tear diseases, the diseases due to habit disorders—heart disease, high blood-pressure, hardening of the arteries, softening of the brain, cancer, diabetes, diseases of the kidney and liver. The result of these habit disorders is appalling and should provide food for thought even to the most indifferent. Each year half a million people die prematurely in the midst of their greatest activities and their best efforts. These deaths are all preventable, if we begin in infancy and childhood to impress the plastic mind with the habits of health, which will be followed subconsciously into what now is considered the dangerous and tragic middle age and the dangerous and tragic period known as old age. If we are as highly civilized as we think we are, and as humane, scientific and wealthy as we claim to be, what excuse have we to offer for permitting millions of people to be constantly ill from preventable disease, and the lives of our fellow beings to be sacrificed to ignorance and neglect?

In view of the great price paid for the neglect of health in childhood days, no boy or girl should be subjected during the period of growth and development to undue and to unnecessary biologic strain or deprivation. No child should be allowed to suffer physical or mental retardation through malnutrition. If such condition unfortunately exists it should be removed at once, for viewed from a broad aspect it is often brought about by causes which have sociological and moral import. Improper food habits are by no means the only cause of malnutrition. Among other equally important causes are physiological defects and pathological processes, lack of home control, chronic overfatigue and improper health habits. These very causes have their roots in the base of the social, hygienic and moral status of the family, in which environment the child is placed by the force of circumstances.

The greatest problem of conservation relates not to forests or mines, but to national vitality. To conserve the latter we must begin by conserving the child.

THE THREATENED SARDINE FISHERIES OF PASSAMAQUODDY BAY

By Dr. N. J. BERRILL

DEPARTMENT OF ZOOLOGY, MCGILL UNIVERSITY

At the mouth of the Bay of Fundy, separating Canada from the United States, is a large sheltered inlet known as Passamaquoddy. It has long been of interest in that it is the scene of the first settlement north of Cape Cod, and has had a checkered history in the border disputes following the War of Independence and of 1812.

The coast in this region was first visited in 1603 by Martin Pring in the *Speedwell,* though no settlement was made; but in the following year De Monts, with Champlain as his pilot, set out with a charter from Henry IV of France to colonize and rule all American territory between the fortieth and forty-sixth degrees of latitude. He first explored the Nova Scotia coast and the Bay of Fundy, during which voyage the St. John River was visited and named, and thence proceeded into the waters of Passamaquoddy. He ascended the river that he named the St. Croix to a small island, which Champlain selected for a fortification and a settlement for the winter. The selection of an island was due to fear of savages, but it was doubtful wisdom since wood and water had to be obtained from the mainland, and before the winter had passed thirty-six men out of the seventy had died of scurvy.

FISHERMEN DIPPING SARDINE INTO SMALL BOAT, HAVING FIRST CONFINED THEM WITHIN THE SEINE NET. THE INNER LINING OF NET TO THE TRAP CAN BE SEEN IN THE BACKGROUND.

Many years later, after the War of Independence, when it was agreed that the river St. Croix should mark the international boundary, there was prolonged dispute as to which of the rivers entering Passamaquoddy Bay was the real St. Croix, and it was settled definitely only when Doucet Island in the Schoodic River was explored and De Monts' forgotten settlement discovered and excavated. For several generations now this region, with its islands, strong currents and fogs, has been the scene of a flourishing sardine industry.

Passamaquoddy itself is an Indian name for "plenty-of-pollack," and the whole area is remarkable for the abundance of young herring or sardine, and of haddock, that are to be found in its waters. The abundance, in fact, is not confined to fishes but is true of such invertebrates as sea-urchins, sea-cucumbers, starfishes, clams and sea-squirts; and in several places along the coast factories have been established for preparing clam-chowder.

This wealth of animal life depends primarily upon a corresponding wealth of minute plant life, and this in turn depends everywhere in the sea on the presence of such salts as phosphates and nitrates. Throughout the oceans the quantity of these salts is very limited, and by the end of summer growth and multiplication of the microscopic plants come to an end through the exhaustion of the salts, and further growth does not take place until after the winter when rivers and destruction of living organisms have replenished the supply. In Passamaquoddy waters, however, conditions are unique. The bay itself is a sheet of water of about one hundred square miles, separated from the Bay of Fundy proper by a chain of islands; and since the rise and fall of the tide is about twenty-five feet, the cold deep

SARDINE BEING TRANSFERRED FROM SMALL BOAT TO THE HOLD OF THE BUYER'S VESSEL. THE SCENE IS IN THE ANGLE FORMED BY THE STAKE FENCE AND THE WALL OF THE TRAP ITSELF.

waters of the Labrador Stream, sweeping south of Nova Scotia, boil and swirl to the surface as they endeavor to force their way through the narrow channels between the islands. In so doing they bring to the sunlit surface where it can be utilized a continual supply of the salts so essential for the growth of the floating plant organisms. To these conditions, then, are due the presence of multitudinous shoals of young herring and other forms of life, and on them depend the sardine industry. This industry is divided between the two countries. The great majority of the fish are caught in Canadian waters by Canadian fishermen, but most of the canning factories are on United States territory. In fact, Eastport and Lubec, the two most northerly coast towns of Maine, depend almost entirely upon such factories.

The method of catching the small herring is based upon the habits of the fish. The shoals usually move close to and parallel with the shore-line, and move out from it only when some obstacle is reached. Traps have consequently been devised that consist of a long fence of stakes and brushwood extending at right angles to the shore and which end in the open mouth of a large circular trap made of the same material. Thus a shoal of herring following the shore and striking the fence would turn outward and follow it into the net-lined trap. Here they swim round and round until caught in a seine and taken out with dip-nets by the fishermen, who sell and transfer them on the spot to the waiting motor vessels of the buyers. The whole is known as a brush-trap or fish-weir and may be found every few hundred yards along the main shore and numerous islands in and outside of Passamaquoddy Bay. Over a thousand are fished every season

SEINE NET HUNG UP ON LARGE WOODEN WHEEL TO DRY. SUCH SEINE WHEELS REST ON FLOATS, USUALLY WITHIN A FEW YARDS OF THE FISH TRAP.

under license from the government, and the catches of herring have to the fishermen alone a value of $750,000 a year, and to this must be added the gross profits of the canning factories and the value of the haddock and pollack fisheries and smoked fish factories.

Such is the present position, but the fate of the fisheries of Passamaquoddy and adjacent waters will probably be settled during the next few months.

The tremendous inrush and outrush of water between the islands that is primarily responsible for the abundance of fish also makes possible the utilization of the tidal force and has given rise to what is known as the Passamaquoddy power project. It is proposed by an international company to build dams in such a way that two immense basins will be formed. By linking with dams and sluice gates the New Brunswick mainland and three islands with Moose Island, on which stands Eastport, and joining the latter to the mainland of Maine, Passamaquoddy Bay will be closed and all ships have to enter and leave through locks. It is proposed to keep this basin of one hundred square miles at high-tide level. A second basin to be maintained at low-tide level would be formed by damming from Eastport across Cobscook Bay to the mainland to the south (see map), so that there would be a head of water available to pass through the turbines of about twenty feet, and of an unlimited volume.

Completed successfully, the project would be one of the greatest engineering feats in the world, but while it is the first of its kind and therefore of an experimental nature, certain results to the neighboring districts are predictable, as is shown from the following extracts from the evidence of Dr. A. G. Huntsman, director of the Biological Station, St. Andrews, N. B. The strong currents and boilings at the entrance to

VIEW UP THE ST. CROIX RIVER FROM THE ATLANTIC BIOLOGICAL STATION AT ST. ANDREWS, WITHIN PASSAMAQUODDY BAY, SHOWING IN THE DISTANCE THE SITE OF DE MONTS' SETTLEMENT ON DOUCET ISLAND (MARKED WITH AN ARROW), AND IN THE FOREGROUND THE FISHERIES INVESTIGATION MOTOR VESSEL, *M. S. Prince*.

Passamaquoddy Bay will be abolished, the rise and fall of the tide within the bay reduced to about five feet and the production of fish food in the region generally very considerably reduced. The sardine, cod, haddock and clam fisheries within the bay will be wiped out, as also the sardine fishery along the whole coast. The surface water will be warmer in summer and colder in winter, and the effect will extend to Nova Scotia and down the coast of Maine, while air temperatures will be similarly affected but over longer distances. Passamaquoddy Bay and the St. Croix River will freeze solid for months every winter and there will be much more ice around the Bay of Fundy.

Thus the power project, if completed, may have an injurious influence on the surrounding district apart from the

WOODEN LIGHTHOUSE, TYPICAL OF THE PASSAMAQUODDY DISTRICT, SHOWING THE PART OF A STAKE FENCE LEADING TO A FISH TRAP.

probable extinction of the New Brunswick and Maine fisheries of that region. On the other hand, as an engineering project, it would be the most ambitious of its kind ever attempted, and also, since there is already a marine biological station within the affected area, it would form an experiment in general marine biology of spectacular size and great importance.

THE PROGRESS OF SCIENCE

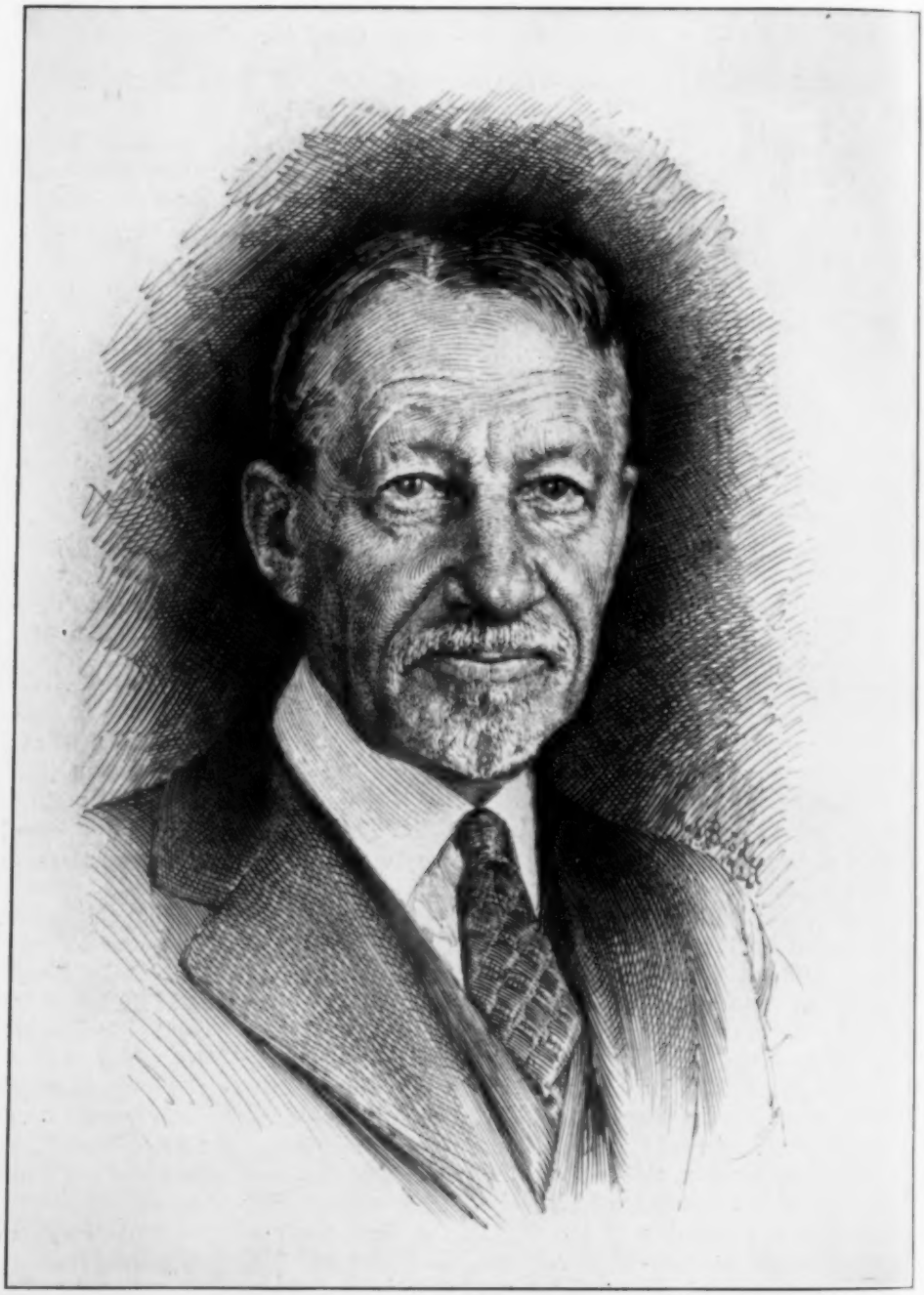
THE THIRTEENTH INTERNATIONAL PHYSIOLOGICAL CONGRESS, BOSTON, AUGUST 19–23, 1929

THE Thirteenth International Physiological Congress, which will be held at the Harvard Medical School this summer under the presidency of William H. Howell, of the Johns Hopkins University, brings to mind other similar gatherings. Of historical interest is the fact that four years after the foundation of the British Physiological Society it issued invitations to foreign physiologists to become their guests at the meeting of the International Medical Congress held in London in August, 1881. The desire was expressed to "intensify by social intercourse the social feeling which already exists between foreign and English physiologists." Among those responding to this invitation was Henry P. Bowditch. Six years later, in 1887, the secretary of the Physiological Society was instructed to put himself in communication with the professor of physiology at Bern, with a view of instituting an international meeting of physiologists in that town during the summer session. The outcome of this suggestion was the holding of the First International Physiological Congress at Basel in 1889, which was attended by 124 physiologists from thirteen different countries. The part taken by Sir Michael Foster in organizing the congress was recognized by the Fifth International Physiological Congress (Turin, 1901) by making him honorary president in perpetuity. The original invitation issued from the Physiological Society began, "It is suggested that International Meetings of Physiologists be held at intervals with the object of promoting the progress of physiology by the interchange of ideas and mutual friendly criticism and of affording opportunities to workers in our science of knowing each other personally." In a private letter to Kronecker, Foster wrote, "We ought to do our best to make it as informal as possible so that we may freely and without reserve exchange opinions."

Except during the disturbance of the war years these congresses have been held triennially as follows: 1889, Basel; 1892, Lüttich; 1895, Bern; 1898, Cambridge; 1901, Turin; 1904, Brussels; 1907, Heidelberg; 1910, Vienna; 1913, Groningen; 1920, Paris; 1923, Edinburgh; 1926, Stockholm.

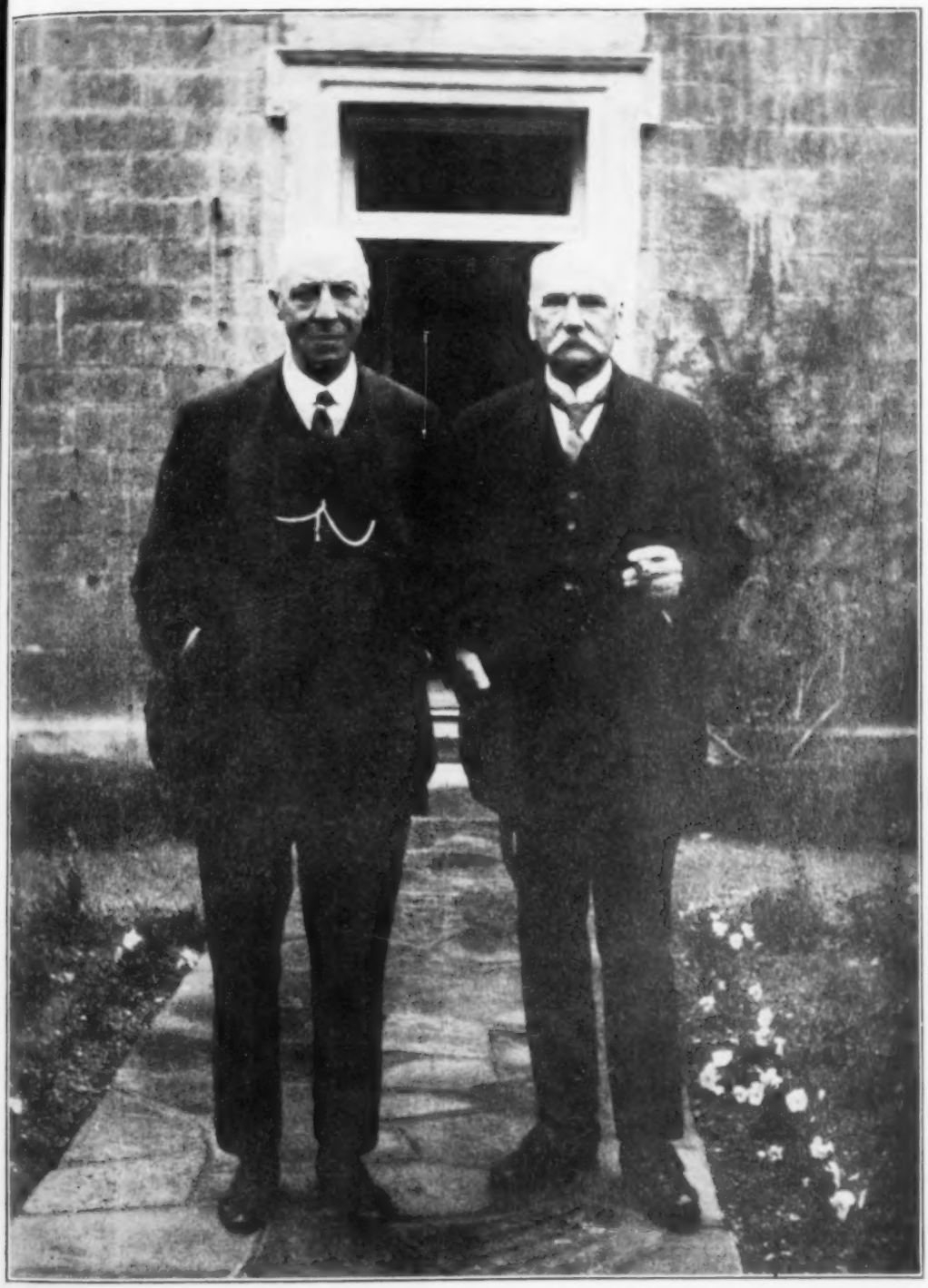
The meeting at Paris was distinctly designated "A Physiological Congress," and many missed the presence of the Germans. At Edinburgh, in 1923, met the first scientific congress held after the war which embraced in its membership men of all countries. Into homes frequently filled with war-time grief, German physiologists were received and made welcome. It made for the healing of the wounds of both nations. When Kossel and when Rubner appeared at different times and places in the program, each was greeted with applause which lasted two or three minutes. Only Charles Richet and Pavlov were received with equal warmth. Kossel and Hans Meyer were the guests of the president of the congress, Sir Edward Sharpey-Schafer, who is to-day the sole surviving member of the original group which founded the British Physiological Society and is one of those who acted on behalf of that society to found the First International Physiological Congress.

A photograph made by A. B. Macallum of Kossel and Schafer standing together before the doorway of Schafer's home at North Berwick, Scotland, presents these two outstanding representatives of their respective countries at the time of the

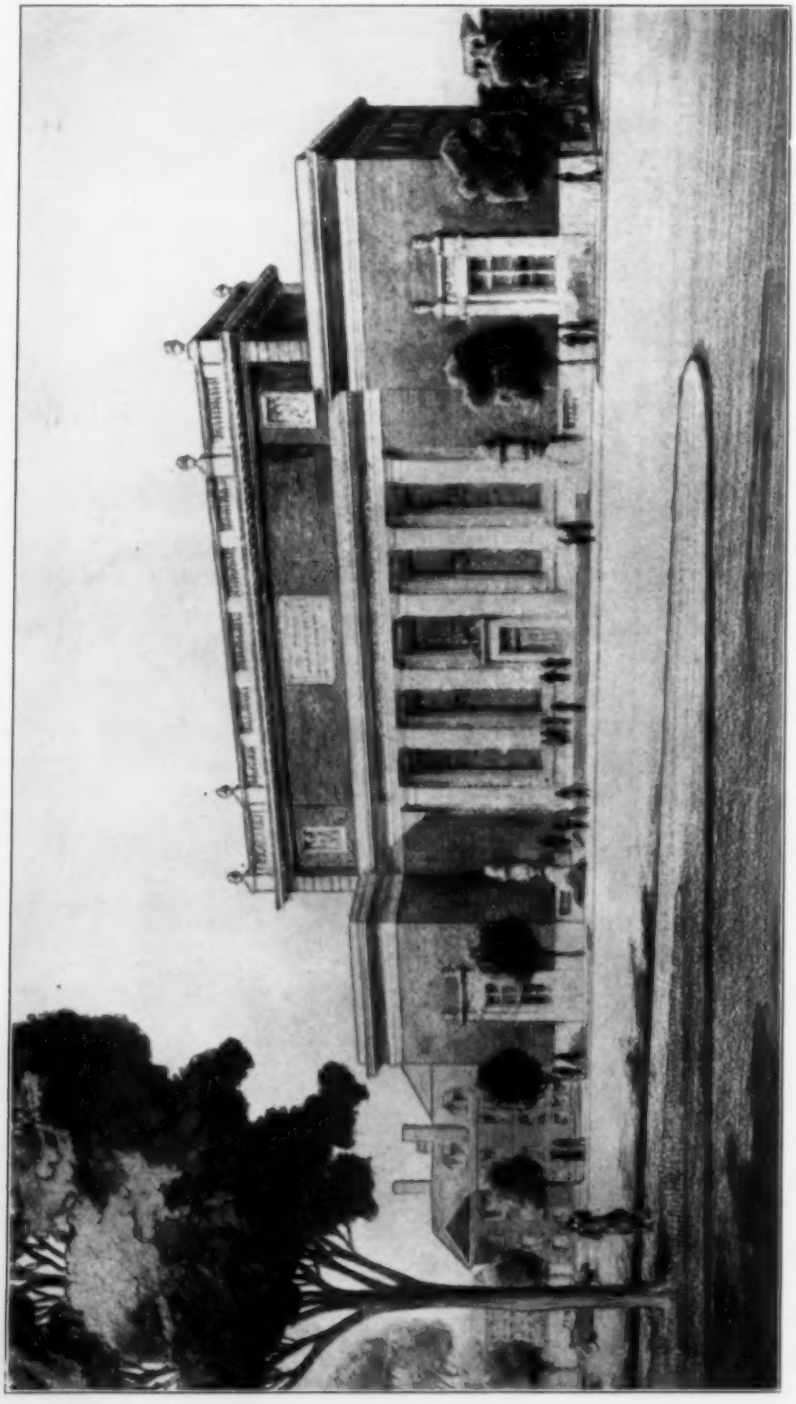


DR. WILLIAM HENRY HOWELL

PRESIDENT OF THE THIRTEENTH INTERNATIONAL PHYSIOLOGICAL CONGRESS.



PROFESSOR SIR EDWARD A. SHARPEY-SCHAFER AND PROFESSOR ALBRECHT KOSSEL



THE NEW HALL ON THE PARKWAY

congress at Edinburgh. Kossel as a young man had attended the meeting at Cambridge (1898). Twenty-five years later he heard himself enthusiastically acclaimed in Britain and on his return to Germany he told a friend how much it had meant to him.

The Twelfth International Congress at Stockholm was royally entertained by that city with a degree of splendor that the six hundred physiologists who were in attendance will never forget. It is probable that more than four hundred foreign physiologists will cross the ocean to attend the congress in Boston this summer. This offers to the United States opportunities to extend hospitality to these visitors which, in a way, may be commensurate with the kindness and friendship shown in the past to American scientists abroad.

GRAHAM LUSK

A NEW CULTURAL CENTER

THE American Philosophical Society, progenitor of all learned societies in the New World, enters upon the third century of its service to man and science with the most ambitious program in its history. That program, as announced at the general meeting of the society held in April, envisions the erection on the Philadelphia Parkway of an adequate building destined to become a cultural center for the inspiration and guidance of "mankind advancing."

As long ago as 1727 Benjamin Franklin, just come of age, recognized the need in America of a force for intellectual leadership. And so, his autobiography tells us, he formed in Philadelphia from among a majority of the well-informed persons of his acquaintance the Junto which later became the American Philosophical Society.

At first the Junto was limited in membership to twelve, but it was not long before Franklin and his friends realized that "virtuosi or ingenious men residing in the several colonies" should be drawn to Philadelphia for meetings and should "maintain constant correspondence." In his call for leaders, dated May 14, 1743, he wrote:

> The first drudgery of settling new colonies, which confines the people to mere necessaries, is now pretty well over and there are many in every province in circumstances that set them at ease and afford leisure to cultivate the finer arts and improve the common stock of knowledge.

Even Franklin, with all his vision and enthusiasm for the growing colonies, could not have predicted the results of that call. From seeds planted by many of the men who answered that appeal for intellectual progress a great nation has risen.

Prosperity and power beyond all dreams "afford leisure to cultivate the finer arts and improve the common stock of knowledge." Distinguished men the world over have been and still are members of the learned society which grew out of Franklin's Junto, and a great cultural center has come to be that society's greatest opportunity.

The society is abandoning its hallowed site on Independence Square not without sacrifice. But to hold to its original purpose, "the promotion of useful knowledge," the move is imperative.

Two years ago, at the celebration of its bicentenary, the members of the society, crowded for space in the old hall, were impressed with renewed force that a new building was an imperative need. A new cultural center was essential for large meetings, for administration and publication activities and the proper housing of the society's expanding library and priceless collections, for study and research and for authoritative dissemination of news in the fields of learning.

In the shadow of Independence Hall the society's home has stood for more

than 140 years. In its rooms and library are priceless collections of manuscripts, paintings and historical relics. In its research and scientific library are more than eighty thousand volumes; the publications of many learned societies as well as its own *Proceedings* and *Transactions;* 13,800 pieces of Frankliniana; Jefferson's original draft of the Declaration of Independence; the written copy of the laws of Pennsylvania prior to 1700; the field notes of the Lewis and Clark expedition and the minutes of the commissioners delegated to determine the Mason and Dixon line.

All around the society's historic building skyscrapers emphasize the material progress of the great nation which was inspired by the Declaration of Independence, for which members of the society were largely responsible. In the cloistered seclusion of its historic meeting room distinguished leaders of thought have gathered to discuss progress in learning and cultural advancement.

The first four presidents of the society after reorganization of 1768 were Franklin, Rittenhouse, Jefferson and Wistar. Fifteen members of the society were signers of the Declaration of Independence; eighteen members were framers of the Constitution of the United States. Nine members of the society have become presidents of the United States and three other presidents have become members.

Among the great leaders of the past have been Jefferson, du Pont de Nemours, Rittenhouse, Rush, Rumford, Priestley, Bowditch, Hassler, Fulton, Day, Henry, Asa Gray, the two Agassizs, Langley, Newcomb, Gibbs, Pickering, Leidy, Cope, George Horn, Ryder, Harrison Allen, Jastrow, Walcott. The membership list of to-day is eloquent of the present.

In the society's meeting room, seated in Franklin's library chair, each president of the society has conducted the stated meetings. On the wall is a portrait of George Washington, by the immortal Gilbert Stuart, and nearby ticks the Rittenhouse clock, used to record the transit of Venus, June 3, 1769. Franklin's battery, his first electrical machine, and portraits of distinguished men, many of them past presidents of the society, are a constant inspiration to the present members at their gatherings.

And a constant reminder that in a flash this treasure house of knowledge and historical record would be lost to mankind!

A spark, a puff of wind, and two centuries of history and contributions to human knowledge would be smouldering embers.

When housed permanently and safely in a modern structure, designed especially to meet the needs of the times, the society feels that an enlarged and progressive program will be possible of accomplishment.

Since the bicentenary, the society has taken important steps toward the achievement of its plan for a new Philosophical Hall. On Philadelphia's Parkway, within sight of the Museum of Art, the Free Library and other such institutions that are vital to cultural progress, the city has set aside a site to be exchanged at the option of the society for its present location. And upon this property, which six years ago cost the city more than a million dollars, it is planned to erect a million-dollar structure.

To this building, designed by Paul Philippe Cret, noted architect and member of the society, will be moved scientific and historical possessions valued at more than two million dollars, including the society's library, much of which now has to be stored in the vaults of a trust company, and is, therefore, inaccessible.

The vision that was Franklin's, when he founded the society, and his leadership, energy and his own contribution, when he helped to make possible the present hall, promise finally to result in

M. HENRI BERGSON

THE DISTINGUISHED FRENCH PHILOSOPHER AND MAN OF LETTERS TO WHOM HAS BEEN AWARDED THE 1927 NOBEL PRIZE IN LITERATURE.

a permanent monument to him and to those who have come after.

The new building is planned not as a monument in stone, however, but as a living memorial to the men who have cleared the frontiers of knowledge in the march of civilization.

Possibilities for greater circulation of new knowledge are of special interest to members of the society. In Franklin's day, weeks and months passed before information could be made available. In these days of telephone, telegraph, high-speed press, air-mail and radio, opportunities for dissemination of information are becoming unlimited. Communication problems have been solved and cooperation with other learned groups is no longer difficult.

To effect a publication and a communication program of world-wide service, the society is enlisting the interest and cooperation of its four hundred American and fifty foreign members. In the new building, under the guidance of a salaried editor, preferably a member of the society, a staff will be employed to effect prompt publication of news of the sciences and humanistic developments, not alone through the present mediums of the society, the *Proceedings* and *Transactions*, but through the establishment of a knowledge bureau, from which research workers, newspaper and magazine editors, lecturers, radio speakers and others may obtain first-hand facts.

This knowledge bureau, members of the society feel, should be of vast service the mankind advancing.

The new building, in addition to the transplanted meeting room, also will provide more adequate opportunity for gatherings to which the public may be invited. Annual meetings in the new hall, with its several rooms for open sessions, should increase in importance each year and the monthly meetings, with more room for non-members, should attract a larger public.

The library, with reading and research rooms nearby, has been designed to make accessible more than five hundred thousand volumes, and the galleries for the society's scientific and historical collections will provide for displays attractive to the public.

In fact, provision is made in the new building for a continually enlarging program of development.

FRANCIS X. DERCUM,
President, American Philosophical Society

A NEW METHOD OF MEASURING REACTION-TIME AND A NEW USE FOR IT IN THE INDUSTRIAL MUSEUM

THE Museums of the Peaceful Arts, New York City, has recently installed a self-operating exhibit whereby the visitor can measure his own reaction-time. In view of the interest manifested in this exhibit, it is believed that a short description and discussion might be of interest.

The fundamentals of the method are quite elementary. For a constant voltage in a circuit containing a galvanometer and resistances the ballistic deflection of the galvanometer is proportional to the time during which the circuit is closed. By using a double contact key, which the visitor operates with his finger, one of the contacts closes an electrical circuit of 60 volts through the tip of the operator's finger. At the same time that this contact is made, the current begins to flow through the galvanometer and continues to flow until the operator removes his finger. The swing of the galvanometer needle as indicated on the ground glass scale indicates the reaction-time in hundredths of a second. A diagram of the electrical connection is shown in Figure II.

It may be of some interest to know that the swing of ballistic galvanometer measures the time limits between the feeling of the electric current in the fingers and the time when the operator breaks the contact by removing his finger. It is quite properly understood that the ballistic swing of a moving coil galvanometer is proportional to the quantity of electricity that flows through it, provided that the period of flow is very short in comparison with the period of the galvanometer. Any galvanometer having a period of more than one half of a second is quite satisfactory for this demonstration.

It is equally well known that the quantity of electricity that flows in a circuit is proportional to the flow of potential multiplied by the duration of the current, thus it is found that the ballistic swing of the galvanometer is a direct measure of the duration of the contact after the operator feels the electrical shock and is consequently a measure of his reaction-time under these particular conditions.

The author used this method a great many years ago for measuring short intervals of time, and it was afterwards adopted by others. However, with the basic knowledge of the principle involved, the Leeds and Northrup Company, Philadelphia, designed and built the present equipment which is being shown at the museum, as may be seen in Figure II. While this obviously seems to consist only of double contact-key resistances, standard cell, and the D'Arsenal galvanometer, nevertheless the design did require considerable thought. For example, it was necessary to find means of determining that the double contact key made the two contacts simultaneously. Also, it was necessary to collaborate the scale in terms of time rather than in terms of quantity of electricity. This time could have been calculated

FIG. I. THE REACTION-TIME APPARATUS

arbitrarily from the electrical units, but it was easier to make the calculation by direct comparison with the Leeds and Northrup standard time equipment.

It is also quite novel to use the standard cell for general service in this way. If the current flow is very small, we believe the Standard West cell is altogether the most suitable.

We have found no inclination on the part of any of our visitors to resist unduly in keeping the current flowing. As a matter of fact, even if the visitor does not read instructions, but merely sees the key and presses it, he is quite likely to measure his reaction-time correctly. The electrical current in the finger is just sufficiently annoying and enough of a surprise to him that the visitor is quite certain to react.

As the exhibit stands at the present time, there are some features that are commendable, and some that perhaps might well be changed. For example, if

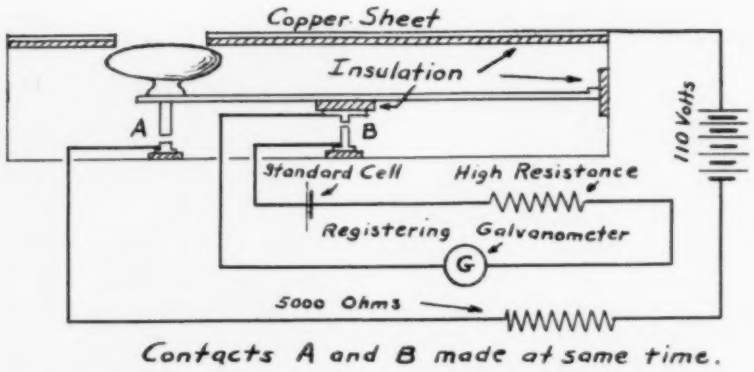


FIG. II. DIAGRAM OF ELECTRICAL CONNECTIONS

we take the first reading of each visitor we find we get values ranging from eight hundredths of a second to as high as thirty-five hundredths, with a preponderance of values in the neighborhood of eighteen hundredths of a second. If, however, the visitor takes a number of readings, the reaction-time measures something different, and is usually of a smaller magnitude. However, in some cases the first value of the reaction-time is smallest, and all the succeeding values are high. We do not have data, however, to justify making any deduction. At least, I do not wish to hazard a conflict with the psychologists.

F. C. BROWN,
Director

INDEX

NAMES OF CONTRIBUTORS ARE PRINTED IN SMALL CAPITALS

Agricultural Building at Washington, 479
ALLEN, W. E., Ocean Plankton, 232
American Association for the Advancement of Science, The New York Meeting, H. F. OSBORN, 5; Convocation Week Meeting, 183; The President, 185
Archibald, Ray C., Portrait, 31
ARNOLD, L. K., Corn-stalks and Cobs, 463
Astrophysical Observatory of the California Institute of Technology, 93

BARNES, H. E., Religion in a Secular Age, 430
BECK, E., Lightning Voltages, 179
Bergson, Henri, Portrait, 571
BERKEY, C. P., Geologic Explorations in Asia, 193
BERRILL, N. J., Sardine Fisheries, 560
BIOLETTI, F. T., Quality in Grapes, 393
Biological Theory, W. M. WHEELER, 97
BLANCHARD, W. O., Europe and the Power Map, 62
BOAS, F., Migrations of Asiatic Races, 110
BOWIE, W., Isostasy and Geological Thought, 385
BRADLEY, J. H., JR., Children of the Sun, 122; Tales that Dead Men Tell, 527
Bridgman, P. W., Portrait, 31

CAJORI, F., Christiaan Huygens, 220
Cattell, J. McKeen, Portrait, 25
Chamberlin, Thomas Chrowder, B. WILLIS, 88
CLARK, A. H., Evolution and Religion, 446
CLARK, G. L., X-ray Applications in Life, 172
CLARK, N. A., Vitamins and Plants, 343
Climatology, R. DEC. WARD, 156
Cole, Fay-Cooper, Portrait, 37
COMPTON, A. H., What is Light?, 289
Corn-stalks and Cobs, L. K. ARNOLD, 463
Coulter, John M., Portrait, 21
Culture, A New Center, 569

"Dana" Expedition, 381
DANFORTH, R. E., Human Evolution, 67
DAVISSON, C. J., The Scattering of Electrons by Crystals, 41
Davisson, Clinton Joseph, Portrait, 92
Dean, Bashford, Portrait, 190; 191

EDDY, W. H., Nobel Prizes in Chemistry, 375
Einstein, and America, F. FRANKLIN, 279; Portrait, 280, 281; Manuscript, Facsimile, 480
ELDRIDGE, J. A., Consistency of Science, 363
Electrons, The Scattering of, by Crystals, C. J. DAVISSON, 41
ELLWOOD, C. A., The Future of Science, 539
Emotions, C. A. RUCKMICK, 252
VON ENGELN, O. D., Falling Water, 422
EPSTEIN, S., Vaccines in Surgery, 56
ESSIG, E. O., Man's Influence on Insects, 499
Europe and the Power Map, W. O. BLANCHARD, 62
Everglades, J. K. SMALL, 80
Evolution, Human, R. E. DANFORTH, 67; in Tools, M. FAIRCHILD and H. HART, 71; and Religion, A. H. CLARK, 446

FAIRCHILD, M., and H. HART, Evolution in Tools, 71
FENNEMAN, N. M., Personally Conducted, 451
Fishes, Sympathy among, E. W. GUDGER, 266; and Insulin, I. E. GRAY, 271
Flexner, Simon, Portrait, 19
FORD, J., Good Housing, 322
FRANKLIN, F., Einstein and America, 279

GAGE, S. H., Lampreys and Their Ways, 401
Gasoline, R. B. SMITH, 336
Geologic Explorations in Asia, C. P. BERKEY, 193
Geological, Thought and Isostasy, W. BOWIE, 385; Survey, U. S., Fifty Years of, 471
Geology, Study of, B. WILLARD, 52
Goldberger, Joseph, 282; Portrait, 283
Goldforb, A. J., Portrait, 37
von Graefe, Albrecht, T. KOPPÁNYI, 318
Grapes, Quality in, F. T. BIOLETTI, 393
GRAVES, F. P., The Library at Louvain, 134
GRAY, I. E., Insulin and Fishes, 271
GUDGER, E. W., Sympathy among Fishes, 266

Hale, George Ellery, Presentation of Portrait to National Academy of Sciences, 379, 380
Heredity and Disease, W. V. LAMBERT, 118
HERRE, A. W., The Sibutu Islands, 304
Hoover, President, Portrait, 477
HOUGH, W., Culture and Population, 513
Housing, Good, J. FORD, 322
Huygens, Christiaan, F. CAJORI, 220

INLOW, W. DEP., The Spleen, 549
Insects, Man's Influence on, E. O. ESSIG, 499
Instinct and Man, M. SCHOEN, 531

Jack the Giant Killer, H. B. WEISS, 126

KAEMPFFERT, W., The Rosenwald Industrial Museum, 481
Kelley, Truman L., Portrait, 39
KEYES, D. B., The Original Reflux, 274
King, Clarence, Portrait, 472
KING, R. W., Physics in Industry, 225
KOPPÁNYI, T., Albrecht von Graefe, 318

LAMBERT, W. V., Heredity and Disease, 118
Lampreys and Their Ways, S. H. GAGE, 401
Language, Model, M. TALMEY, 330
LAUFER, B., The American Plant Migration, 239
Leverett, Frank, Portrait, 37
LEVINE, V. E., Nutrition in Child Hygiene, 554
Light, What is It?, A. H. COMPTON, 289
Louvain, The Library at, F. P. GRAVES, 134

McLaughlin, G. D., and J. H. Highberger, Problems of Tanning, 417
Mathews, A. P., Quantity of Life of an Organism, 518
Maximow, Alexander A., Portrait, 382
Medal, Gold, John Fritz, 476
Mees, C. E. Kenneth, Portrait, 33
Metfessel, M., The Vibrato, 217
Migrations of Asiatic Races, F. Boas, 110
Millikan, Robert A., Portrait, 184; 185
Mooers, C. A., Portrait, 35
Morgan, A. H., Fresh-water Sponges, 152
Museum of Natural History, American, G. N. Pindar, 285
Musical Instruments, The King of, A. D. Weeks, 457

Nobel Prizes, 186; in Chemistry, W. H. Eddy, 375
Noyes, Arthur A., Portrait, 10
Nutrition in Child Hygiene, V. E. Levine, 554

Organism, Quantity of Life of an, A. P. Mathews, 518
Osborn, H. F., The American Association for the Advancement of Science, 5; Portrait, 6

Parasitism, H. W. Stunkard, 349
Pasteur, Louis, Memorial, 189
Pegram, George B., Portrait, 28
Personally Conducted, N. M. Fenneman, 451
Physics in Industry, R. W. King, 225
Physiology, Thirteenth International Congress of, 565
Pindar, G. N., American Museum of Natural History, 285
Plankton, Ocean, W. E. Allen, 232
Plant Migration, B. Laufer, 239
Plaskett, J. S., Portrait, 33
Population and Culture, W. Hough, 513
Powell, John W., Portrait, 473
Prehistoric Figurines, E. B. Renaud, 507
Progress, W. D. Wallis, 454; of Science, 89, 183, 279, 375, 471, 565
Pupin, Michael I., Portrait, 12

Reaction Time, New Method of Measuring, 572
Reflux, Original, D. B. Keyes, 274
Religion, in a Secular Age, H. E. Barnes, 430; and Evolution, A. H. Clark, 446
Renaud, E. B., Prehistoric Figurines, 507
Rosenwald Industrial Museum, W. Kaempffert, 481
Ruckmick, C. A., Emotions, 252

Sackett, R. L., Portrait, 35
Sardine Fisheries, N. J. Berrill, 560
Schoen, M., Instinct and Man, 531
Science, The Consistency of, J. A. Eldridge, 363; The Future of, C. A. Ellwood, 539
Scientists, Pick-axe, W. E. Spahr, 327
Sibutu Islands, A. W. Herre, 304
Small, J. K., The Everglades, 80
Smith, O. S., Portrait, 475
Smith, R. B., Gasoline, 336
Snyder, T. E., Termites and Architecture, 143
Spahr, W. E., Pick-axe Scientists, 327
Spleen, W. DeP. Inlow, 549
Sponges, Fresh-water, A. H. Morgan, 152
Stunkard, H. W., Parasitism, 349
Sun, Children of the, J. H. Bradley, Jr., 122

Tales that Dead Men Tell, J. H. Bradley, Jr., 527
Talmage, S. B., Spoor of a Thunderbolt, 368
Talmey, M., A Model Language, 330
Tanning, Problems of, G. D. McLaughlin and J. H. Highberger, 417
Termites and Architecture, T. E. Snyder, 143
Thunderbolt, Spoor of a, S. B. Talmage, 368
Trelease, Sam F., Portrait, 28
Tropical Life for White Men, J. H. Whitaker, 263
Turner, H. H., Portrait, 28

Vaccines in Surgery, S. Epstein, 56
Vibrato, M. Metfessel, 217
Vitamins and Plants, N. A. Clark, 343
Voltages, Lightning, E. Beck, 179

Walcott, Charles D., Portrait, 474
Wallis, W. D., Progress, 454
Ward, R. DeC., Climatology, 156
Warren, Howard C., Portrait, 39
Wate, Falling, O. D. von Engelin, 422
Weeks, A. D., The King of Musical Instruments, 457
Weiss, H. B., Jack the Giant Killer, 126
Wheeler, W. M., Biological Theory, 97
Whitaker, J. H., Tropical Life for White Men, 263
Wieland, Heinrich, Portrait, 377
Willard, B., Geology, Study of, 52
Willis, B., Thomas Chrowder Chamberlin, 89
Wilson, E. B., Portrait, 15
Wilson, Edmund B., Presentation of Daniel Giraud Elliot Medal to, 91
Windaus, Adolph, Portrait, 376

X-ray Applications, G. L. Clark, 172

Sudhoff's First Book in English

ESSAYS IN THE HISTORY OF MEDICINE

By

KARL SUDHOFF, M.D.

Professor of History of Medicine in the University of Leipzig, 1895–1924

Translated by various hands and edited, with foreword and biographical sketch,

By

FIELDING H. GARRISON, M.D.

Lieutenant Colonel, Medical Corps, U. S. Army

CONTENTS

Foreword
Biographical Sketch
I. Aims and Value of Medical History in the Self-Development and Professional Life of the Physician
II. Tendencies and Aspirations in Medical History
III. What is History of Medicine
IV. Periods in the Development of Medical Science
V. Schools of Physicians
VI. Ways and Means of Research in the History of Hygiene
VII. The Hygienic Idea in its Manifestations in World History
VIII. History and Epidemiology
IX. Epidemiologic Rules of the Past
X. Aims, Means and Methods in Medical Archaeology
XI. Medicine in the Stone Age
XII. Disease Demonology and Healing Customs of the Teutons
XIII. Paleopathological Problems and Postulates—Tuberculosis in Prehistoric Times
XIV. Galen: The New Corpus Medicorum Graecorum and the Modern Medical World
XV. Ancient Italian Representations of Human Viscera as Votive Offerings
XVI. Female Generative Organs as Votive Offerings
XVII. Healing Miracles of SS. Cosmos-Damian and Cyrus-John
XVIII. Aims and Methods of Investigation in the History of Mediaeval Medicine in Western Europe
XIX. Salerno: A Mediaeval Health Resort and Medical School on the Tyrrhenian Sea
XX. Hygienic Directions for Travellers During the Middle Ages
XXI. A Turning Point in Hospital Administration in Mediaeval Europe
XXII. The Origin of Syphilis
XXIII. The Literary Remains of Paracelsus
XXIV. Lorenz Fries and the First World-Map Containing the Name America
XXV. Leonardo da Vinci
XXVI. Medical Data in Greek Papyric Archives
XXVII. Medicine and Art
XXVIII. Painting and the History of Medicine
XXIX. An Historical Museum of the Healing Art
XXX. Julius Leopold Pagel
XXXI. Julius Preuss
XXXII. Max Höfler
XXXIII. In Memory of Johannes Müller
XXXIV. Goethe and Johannes Müller
XXXV. Goethe's Physician, Privy Councilor Abel
XXXVI. Goethe and Maximiliane von La Roche
XXXVII. Faust in the Rhineland
XXXVIII. Easter Twilight on the Aventine

Crown octavo of 400 pages, illustrated, stamped in gold on extra blue cloth, $5.00

PUBLISHED BY MEDICAL LIFE PRESS

12 Mt. Morris Park West New York, N. Y.

NEW BOOKS OF SCIENTIFIC INTEREST

(*Continued from inside front cover*)

The Profession of Engineering. Edited by DUGALD C. JACKSON and W. PAUL JONES. 124 pp. $1.50. John Wiley & Sons.

From the discussions of the preparation and qualifications needed for the engineering profession, through the essays on the main branches of engineering, to the address on the engineer's contribution to modern life, the intention has been to give a non-technical, yet detailed, conception of the profession of engineering.

An Introduction of Biophysics. DAVID BURNS. 567 pp. 116 illustrations. $7.00. Macmillan Company.

A survey of biophysics, in which is shown the part which physics has come to play in the solution of the problems of physiology. The problems of life, and vertebrate life in particular, have been viewed through the physicist's eyes.

Statistical Mechanics. R. H. FOWLER. 560 pp. $10.50. Cambridge University Press; American Agent, Macmillan Company.

A monograph on the theory of the properties of matter in equilibrium. In general, the theory and its simpler practical applications have been developed concurrently to avoid too continuous sequence of unapplied theorems. The more complicated applications form the subject-matter of the later chapters.

Freshman Algebra. JAMES B. SHAW. 133 pp. $2.00. Thomas Y. Crowell Company.

This text for liberal arts courses is written from the standpoint that the study of mathematics should be based upon its beauty and not upon its utility. It takes up the history of algebra, and proceeds step by step to the different elements, such as integers, factoring, quadratics, etc.

Plant Diseases. F. T. BROOKS. 368 pp. $7.00. Oxford University Press.

An account of the diseases of British crop plants, including an outline of important plant diseases in other countries. The book will be useful to the student of botany, agriculture, horticulture and forestry, but it is designed particularly for those carrying out investigations on the diseases of plants.

The Cowbirds. HERBERT FRIEDMANN. 395 pp. Illustrated. $6.00. Charles C. Thomas.

A study in the biology of social parasitism, based on five years' work in central New York, Argentina and the Texan-Mexican border. It contains detailed data on the genera, species, migration, song and call notes, eggs, the young, food, plumages, common names, enemies, etc.

A Handbook of the Dragonflies of North America. JAMES G. NEEDHAM and HORTENSE B. HEYWOOD. 367 pp. $7.00. Charles C. Thomas.

This is a book for collectors of dragonflies and for students of their natural history. It aims to furnish a means of finding the names of North American species, and to report some observations on their habits. It contains keys, descriptions and figures.

From a Bird Lover's Diary. ARTHUR ASTLEY. 302 pp. Illustrated. $3.00. Sheldon Press, London; American Agent, Macmillan Company.

These studies of British birds are the outcome of the author's lifelong habit of bird watching. He tells of his personal experience with a typical bird for each month of the year. Matters such as song and flight are brought into line with the latest theories.

Discoveries and Adventures in Central America. THOMAS GANN. 256 pp. Illustrated. $5.00. Charles Scribner's Sons.

A narrative of the author's experiences in the search for relics of the ancient Mayan civilization in the interior of Central America. Twelve stelae were among the most interesting discoveries made. This English author is a fellow of the American Geographical Society.

Altai-Himalaya. NICHOLAS ROERICH. 407 pp. Illustrated. $5.00. Frederick A. Stokes Company.

The travel diary of a Russian artist kept during his journeys through India, Mongolia and Tibet. We hear of visits to ancient monasteries, of discourses with monks and pilgrims, of old manuscripts and traditions, of Confucianism and Buddhism and of the hardships the expedition had to endure.

In Java. JOHN C. VAN DYKE. 310 pp. $2.50. Charles Scribner's Sons.

The towns and seas, rivers and mountains, men and animals of Java, and the neighboring islands of Celebes, Borneo, Moluccas and Bali, are the subjects of these travel sketches, made by the author during a winter and spring in the Dutch East Indies.

The Radio Industry. A symposium. Introduction by DAVID SARNOFF. Foreword by ANTON DE HAAS. 321 pp. $5.00. A. W. Shaw Company.

The story of the development of the radio industry, as told to the students of the Graduate School of Business Administration, George F. Baker Foundation, Harvard University, by leaders of the industry in a series of lectures given in 1927 and 1928.

Everybody's Aviation Guide. VICTOR W. PAGÉ. 238 pp. Illustrated. $2.00. Norman W. Henley Publishing Company.

A simplified treatise, in question and answer form, which considers all types of aircraft, both lighter-than-air and heavier-than-air forms, gives the principles on which their operation is based, and describes the construction of principal types of dirigibles and airplanes.

Elementary Principles of Education. EDWARD L. THORNDIKE and ARTHUR I. GATES. 327 pp. $1.60. Macmillan Company.

The chief topics of this volume, which is intended for a first course in principles of education, are: objectives of education, functions of the school, characteristics of children from birth to maturity, principles underlying the learning and teaching process and the selection of material for the school curriculum.

(*Continued on page iv*)

New McGraw-Hill Books

Wardle—Problems of Applied Entomology

By **Robert A. Wardle**, Professor of Zoology, University of Manitoba; formerly Associate Professor of Entomology, University of Minnesota and Lecturer in Economic Zoology, University of Manchester. **587 pages, 6 x 9, 31 illustrations** $6.00

A thorough and comprehensive treatment of the important problems facing economic entomologists. The book describes and summarizes the recent research and developments in the field of applied entomology.

Weldon—Economic Biology

A Text for Students of Agriculture and General Biology

By **George P. Weldon**, Instructor in Biology, Entomology and Pomology, Chaffey Union High School and Junior College, Ontario, Calif. *McGraw-Hill Vocational Tests.* **457 pages, 5½ x 8, 191 illustrations** $2.50

A text on biology dealing with the economic phases of animal and plant life. The book shows the applications of biology in practical agriculture and in other branches of everyday life. It gives much information on the control of some of the more common insect pests and plant and animal diseases.

Lynn—Pharmaceutical Therapeutics

With Pharmacology, Posology and Toxicology

By **Eldin V. Lynn**, Professor of Pharmacology and Chemistry, University of Washington, School of Pharmacy. *McGraw-Hill Publications in Pharmacy.* **431 pages, 5½ x 8** $4.00

A unified text on pharmacology and toxicology for students of pharmacy. Under each drug are considered its physiological actions most important in the treatment of disease and most significant in the diagnosis and treatment of poisoning. The principles of its therapeutic employment are given in outline and the symptoms of toxic effects are presented. Finally, the average and maximum doses are given, both in the text and as a list in the appendix. All of the drugs comprised by the two pharmacopoeias in the English language, by the National Formulary, by New and Nonofficial Remedies, and all others which are usually handled in the modern drug store are included.

Humphreys—Physics of the Air—New Second Edition

By **W. J. Humphreys**, Meteorological Physicist, United States Weather Bureau. Second Edition, revised and enlarged. **634 pages, 6 x 9, 226 illustrations** $6.00

A thorough revision of this widely-known book on all branches of the physics of the air. It affords a thorough discussion of the mechanics and thermodynamics of the atmosphere, of meteorological acoustics, of atmospheric optics and of the factors involved in climatic control.

Walden—Salts, Acids and Bases—Electrolytes—Stereochemistry

By **Paul Walden**, University of Rostock. *George Fisher Baker Non-Resident Lectureship in Chemistry At Cornell University Series.* **397 pages, 6 x 9, illustrated** $4.00

Lectures dealing with three fields of scientific work in which Professor Walden has been especially interested: The History of Chemistry, Electrochemistry and Stereochemistry. These lectures were delivered at Cornell University during the First Semester of 1927–1928.

Send for copies of these new books on approval

McGRAW-HILL BOOK COMPANY, Inc.

Penn Terminal Building

370 Seventh Avenue **New York**

NEW BOOKS OF SCIENTIFIC INTEREST

(*Continud from page ii*)

The Story of Engineering in America. CHELSEA FRASER. 461 pp. Illustrated. $2.50. Thomas Y. Crowell Company.

In non-technical style the reader is told the story of some of the great engineering feats, such as roads and skyscrapers, railroads and canals, dams and bridges, tunnels, subways, harbors, docks and lighthouses, mines; and many other public works.

The Bases of Modern Science. J. W. N. SULLIVAN. 274 pp. $2.00. Doubleday, Doran & Company, Inc.

The most essential and important concepts of the science of physics are outlined in popular language in this volume. The Newtonian conception, the ether theory, the electric theory of matter, relativity—these and many others are explained without the use of mathematical formulae.

Walk, Look and Listen. RAYMOND T. FULLER. 295 pp. $2.50. John Day Company.

A collection of informal, non-technical descriptions of a miscellany of natural history objects likely to be encountered on a day's cross-country hike. It tells how to find an owl, a spadefoot toad, a wild fox, a raccoon, a flying squirrel, a bat.

Society and Its Problems. GROVE S. DOW. 681 pp. $3.00. Thomas Y. Crowell Company.

A thoroughly revised edition of this introduction to the principles of sociology. The volume is divided into six parts, which consider progressively the nature of sociology, problems pertaining to population, social institutions, an analysis of society, social maladjustment and social progress.

RECENT BOOKS OF SCIENTIFIC INTEREST

Physician and Patient. Edited by L. EUGENE EMERSON. 244 pp. $2.50. Harvard University Press.

This book is intended for all who are interested in medicine; physicians, nurses, students and all who have ever been sick, ever will be sick, or have anything to do with the sick. It emphasizes the view that not alone the patient's body but also his mind should be cared for by the physician.

The Seas. F. S. RUSSELL and C. M. YONGE. 363 pp. $5.00. Frederick Warne & Company, Ltd.

The work sets forth in popular style our knowledge of the under-sea world. It discusses the sea bottom, coral reefs, color and phosphorescence, feeding of marine animals, sea water, methods of oceanographical research and related subjects.

Physics of the Air. W. J. HUMPHREYS. 641 pp. $6.00. McGraw-Hill Book Company.

This book covers all branches of the physics of the air. It contains a thorough discussion of the mechanics and thermodynamics of the atmosphere, of meteorological acoustics, of atmospheric optics and of the factors involved in climatic control.

A Guide to the Winter Birds of the North Carolina Sandhills. MILTON P. SKINNER and JOHN WARREN ACHORN. 295 pp. $4.00. Science Press Distributing Company.

A book primarily for people who are, or may wish to become, interested in birds rather than for scientists. Technical terms are avoided so far as possible, but care has been taken to make every statement scientifically accurate.

The books noted above may be obtained at the publishers' regular rates from

THE SCIENCE PRESS DISTRIBUTING COMPANY, A Scientific and Educational Book Service
Grand Central Terminal, New York, N. Y.

Vol. XXVIII, No. 6 June, 1929 Whole No. 165

The Scientific Monthly

An Illustrated Magazine Devoted to the Diffusion of Science

J. McKEEN CATTELL, Editor

WARE CATTELL, Associate Editor

Published by THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.

NEW YORK, N. Y., Grand Central Terminal

Single Number, 50 Cents Yearly Subscription, $5.00

COPYRIGHT 1929 BY THE SCIENCE PRESS

Entered as second-class matter at the post office at Lancaster, Pa., July 18, 1923, under the Act of March 3, 1879.

Department of Spanish Studies

of the

University of Porto Rico

in collaboration with

THE CENTRO DE ESTUDIOS HISTORICOS OF MADRID and COLUMBIA UNIVERSITY OF NEW YORK

DIRECTOR

Federico de Onis
Professor in Columbia University,
Member of the Centro de Estudios Históricos

HONORARY DIRECTORS

Ramon Menendez Pidal
Director of the Centro de Estudios Históricos
T. Navarro Tomas
Professor of the Centro de Estudios Históricos
John L. Gerig
Department of Romance Languages, Columbia University,

Graduate and Undergraduate Courses
Related Work in Other Departments

Address: Dean of Administration, University of Porto Rico, Rio Piedras, Porto Rico.

SUMMER SESSION, 1929—
July 1 to August 14

UNIVERSITY YEAR, 1929-30—
August 19 to May 28

PHOTO-ELECTRIC CELLS

THE BURT *CELL*

Without Fatigue—Highly Sensitive—Absolutely Reproducible—Instantaneous in Response

The **BURT-CELL** is made by a new method and should not be confused with any other photo-electric cell. By a special process of electrolysis, the photo-electric metal is introduced into a highly evacuated bulb directly through the glass wall of the bulb, giving photo-electric material of absolute purity. The superiority of the **BURT-CELL** is due to these features, making possible results never before obtainable.

Described in Bulletin 271

QUARTZ CELLS—We are pleased to announce that we are manufacturing reproducible quartz photo-cells for measurement of ultra-violet.

We also manufacture the **STABILIZED OSCILLOSCOPE**—the only **VISUAL OSCILLOGRAPH** having a linear time axis and no inertia—giving an accurate picture of high frequency wave forms. This is a most powerful tool for the study of periodic phenomena.

Write for Bulletin 273

DR. ROBERT C. BURT

Manufacturing and Consulting Physicist

327 S. Michigan Ave., Pasadena, Calif.

Before You Purchase LOOK

Book buying by title is hazardous—one wants to *see*. Send for any below which inveigle your interest. Look them over five days before deciding about purchase. Then keep only the ones you want.

"Shopping" by mail is modern, leisurely, dignified.

Outdoor Books for Summer Reading

The Beaver **$3.00**

EDWARD ROYAL WARREN. Number II of the Monographs of the American Society of Mammalogists. *Cloth, 5¼ x 8, xx + 177 pages, 79 illustrations, bibliography, index.*

Animal Life of the Carlsbad Cavern **$3.00**

VERNON BAILEY. Number III of Monographs of the American Society of Mammalogists. *Cloth, 5¼ x 8, xiii + 195 pages, 65 half-tones, 1 map, 1 color map.*

Fogs and Clouds **$4.00**

W. J. HUMPHREYS. *Art boards, stained top, 5¼ x 7⅜, xvii + 104 pages, 94 half-tones, bibliography, index.*

Leaf Mining Insects **$6.00**

JAMES G. NEEDHAM and others. *Cloth, 6 x 9, viii + 351 pages, 91 figures, bibliography of over 250 references, index.*

Meteors **$6.00**

CHARLES P. OLIVER. *Cloth, gold stamped cover design, stained top, 6 x 9 xv + 761 pages, illustrated, index.*

Naturalist's Guide to the Americas **$8.00**

VICTOR E. SHELFORD. *Flexible fabrikoid, cover design, stained top, 6 x 9, xv + 761 pages, illustrated, index.*

Rain Making and Other Weather Vagaries **$2.50**

W. J. HUMPHREYS. *Cloth, 5 x 7½, x + 157 pages, index.*

Tree Ancestors **$3.00**

EDWARD W. BERRY. *Cloth, 6 x 9, vi + 270 pages, 48 illustrations, index.*

Get a group and look them over. You can't get less than a pleasant evening's diversion.

THE WILLIAMS & WILKINS COMPANY, . . BALTIMORE, U. S. A.

Publishers of Scientific Books and Periodicals

Published by HOEBER

"TWO NEW AMERICAN STANDARDS"

McClung's HANDBOOK OF

MICROSCOPICAL TECHNIQUE

For Workers in Both Animal and Plant Tissues

By Wm. H. F. Addison, Ezra Allen, Jos. L. Appleton, Jr., Robert Chambers, William V. Cone, Harold J. Conn, Edmund V. Cowdry, Ulric Dahlgren, Hal Downey, Sophia H. Eckerson, N. Chandler Foot, Robert T. Hance, Chester H. Heuser, Raphael Isaacs, Frank B. Mallory, Clarence E. McClung, Josephine W. McNabb, Frederic Parker, Jr., Wilder Penfield, Florence R. Sabin, Paul G. Shipley, Ethel M. Slider, Wm. Randolph Taylor, David H. Wenrich.

Edited by C. E. McCLUNG, PH.D.

Professor of Zoology, and Director of Zoological Laboratory, University of Pennsylvania

This work has been planned to be exactly what its name indicates and its comprehensiveness and practicality are perhaps best expressed in the words of a purchaser: "This work is as important to me as my microscope." The names of the contributors are alone sufficient to attest the authority of each chapter.

Large 8vo, Waterproof Sturdite (uniform with Special Cytology), 43 Illustrations, $8.00 net

SPECIAL CYTOLOGY

The Form & Functions of the Cell in Health & Disease

A TEXTBOOK FOR STUDENTS OF BIOLOGY & MEDICINE

By Leslie B. Arey, Percival Bailey, R. R. Bensley, C. H. Bunting, Alexis Carrel, A. E. Cohn, G. W. Corner, E. V. Cowdry, Hal Downey, G. Carl Huber, J. Albert Key, E. B. Krumbhaar, Albert Kuntz, Leo Loeb, C. C. Macklin, M. T. Mackin, E. F. Malone, Frank C. Mann, David Marine, A. A. Maximow, Edward B. Meigs, C. W. Metz, W. S. Miller, Eugene L. Opie, Wilder Penfield, A. T. Rasmussen, J. Parsons Schaeffer, G. E. Shambaugh, P. G. Shipley, G. N. Stewart, Charles R. Stockard, D. L. Stormont, Frederick Tilney, T. Wingate Todd, G. B. Wislocki.

Edited by EDMUND V. COWDRY

Professor of Cytology, Washington University, St. Louis

"A BOOK EVERY BIOLOGIST WILL WANT TO OWN. . . . The latest literature is here copiously referred to. . . . The greatest American contribution to the encyclopedias of histology."—*Eugenical News.*

2 vols., Large 8vo, 1376 Pages, 693 Illus., Handsomely Bound in Waterproof Sturdite, $20.00 net

PAUL B. HOEBER, INC., PUBLISHERS, 76 FIFTH AVE., N. Y.

Publishers of *Annals of Medical History, The American Journal of Surgery, The American Journal of Roentgenology & Radium Therapy,* etc.

ORDER BLANK 160 SM

PAUL B. HOEBER, Inc., Publishers, 76 Fifth Avenue, New York 1929

Send me.....cop.....of

....McClung—Handbook of Microscopical Technique - - - - - - - - $8.00 net

....Cowdry—Special Cytology - - - - - - - - - - - - $20.00 net

Enclosed find check for.....in payment. ☐ Send C. O. D. ☐ Charge to my account.

Signed..... *Address*.....

Our complete CATALOGUE will be sent you upon request

New World Antiquities

Archeological expeditions sent out under the auspices of the Department of Anthropology of the University of California and the Museum of the American Indian, Heye Foundation, have found evidences—wholly pre-Caucasian—of the rich cultural life of a pre-historic Indian tribe that lived about 1000 B. C. in the Humboldt Mountains of west-central Nevada.

PROFESSOR KROEBER has written the preface to the interesting report recently issued and entitled

Lovelock Cave

By L. L. LOUD and M. R. HARRINGTON

The value of the book is enhanced by illustrations abundant in number and of exceptional excellence in execution (Murnik, engraver).

183 pages, 93 illustrations, $2.50 postpaid

Order promptly; the edition is small and sales are brisk

Address:

University of California Press

Berkeley, California

Publishers: G. E. STECHERT CO., New York—DAVID NUTT, London—FELIX ALCAN, Paris—AKAD. VERLAGSGESELLSCHAFT, Leipzig—NICOLA ZANICHELLI, Bologna—RUIZ HERMANOS, Madrid—RENASCENCA PORTUGUESA, Porto—THE MARUZEN COMPANY, Tokyo

"SCIENTIA"

INTERNATIONAL REVIEW OF SCIENTIFIC SYNTHESIS

Published every month (each number containing 100 to 120 pages)

Editor: EUGENIO RIGNANO

IS THE ONLY REVIEW the contributors to which are really international.

IS THE ONLY REVIEW that has a really world-wide circulation.

IS THE ONLY REVIEW of scientific synthesis and unification that deals with the fundamental questions of all sciences: the history of the sciences, mathematics, astronomy, geology, physics, chemistry, biology, psychology and sociology.

IS THE ONLY REVIEW that by means of enquiries among the most eminent scientists and authors of all countries (*On the philosophical principles of the various sciences; On the most fundamental astronomical and physical questions of current interest, and in particular on relativity; On the contribution that the different countries have given to the development of various branches of knowledge; On the more important biological questions, and in particular on vitalism; On the social question; On the great international questions raised by the World War*), studies all the main problems discussed in intellectual circles all over the world, and represents at the same time the first attempt at an international organization of philosophical and scientific progress.

IS THE ONLY REVIEW that among its contributors can boast of the most illustrious men of science in the whole world. A list of more than 350 of these is given in each number.

The articles are published in the language of their authors, and every number has a *supplement containing the French translation of all the articles that are not French.* The review is thus completely accessible to those who know only French. (*Write for a free copy* to the General Secretary of "Scientia," Milan, sending 12 cents in stamps of your country, merely to cover packing and postage.)

SUBSCRIPTION: $10.00, Post free **Office: Via A. De Togni 12, Milan 116**

General Secretary: DR. PAOLO BONETTI.

THE STUDENTS' POTENTIOMETER

No. 7651 Students' Potentiometer

THIS two-range instrument, with separate slide-wire connections, has the simplicity and strength necessary for instruction purposes. At the same time it is accurate and flexible enough for use on many important problems. The lower range is particularly valuable for measuring temperatures with noble metal thermocouples, and for precise measurements at low temperatures with base metal couples. The slide-wire is used, independently of the potentiometer circuit, for many bridge measurements where a moderately accurate, calibrated resistance is needed.

Specifications: Two ranges, 0 to 1.6 volts and 0 to 16 millivolts. 15 coils of 10 ohms each and slide-wire having a resistance of 10 ohms with end cells of 90 ohms. Slide-wire has 100 divisions. Limit of error of coil adjustment guaranteed within 0.05 percent; of slide-wire calibration, 0.5 division. Potentiometer current required, 0.01 amperes. Polished bakelite top plate; polished mahogany case with cover.

7651 STUDENTS' POTENTIOMETER $80.00

(Send for Bulletin M-765)

LEEDS & NORTHRUP COMPANY
4901 STENTON AVENUE PHILADELPHIA, PA.

LEEDS & NORTHRUP

Electrical Measuring Instruments
Potentiometer Pyrometers

Hump and Homo Heat Treating Furnaces
Automatic Combustion Control

G-136

THE Universal Laboratory Model ultra-violet lamp provides for precision work the Quartz Mercury Vapor Arc, long recognized as the richest available source of ultra-violet.

To Assist You *in Laboratory Experiments*

HANOVIA ULTRA-VIOLET LAMPS

USE of ultra-violet ray has considerably widened the scope of research work. And laboratory workers are obtaining especially valuable assistance from Hanovia Ultra-violet Lamps. The highly efficient construction of these lamps assures accurate quantity and finest quality of ultra-violet rays.

No doubt many of *your* experiments can be conducted more successfully by the use of a dependable ultra-violet ray generator.

Write today, and find out how you can employ the Universal Laboratory Model in your work. The Director of the Hanovia Laboratory will be happy to send you full data.

Hanovia Chemical & Mfg. Company, Dept. J–13 Chestnut St. & N. J. R. R. Ave., Newark, N. J.

Portraits as men like them

Bachrach
Photographs of Distinction

507 Fifth Avenue
Vanderbilt 7400

In the Grand Central Zone
Hotel
MONTCLAIR
Lexington Avenue
49th to 50th Sts.
NEW YORK CITY

Just Completed and Opened

800 Rooms 800 Baths
Each with Tub and Shower

Radio in Every Room

Room & Bath
$3–$5
tub and shower,
for 2 persons
$4–$6

S. Gregory Taylor, president. Oscar W. Richards, manager.

New York's
Newest Hotel

The Piccadilly

227 West 45th St.
At Broadway
New York

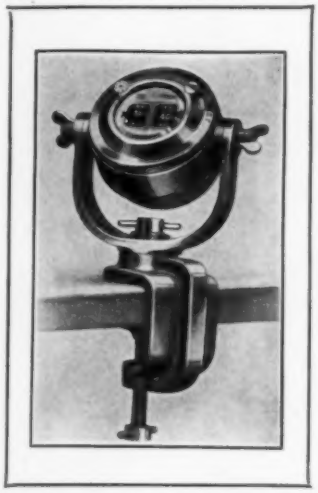
Adjacent to every Activity
600 Bright Sunlit Rooms
Each with Bath, Electric Fan, Ice Water.

Single Room & Bath $3.00
Double Room & Bath $4.50

Exceptional Restaurant and Luncheonette

Wire at our Expense
for Reservations

F. D. Sofield,
Managing Director



It is essential to firmly fix any meter for brake measurement to a motor vehicle in order to eliminate Error.

A quick acting clamp is also available which attaches the Tapley Meter firmly to any running board with one upward movement of the hand; for use where continuous tests are made.

The TAPLEY Brake Testing Meter

For Accuracy, and Maintained Accuracy.
A Certificate of Test is furnished with each Meter.

The Tapley Brake Testing Meter may be used at any speed above 10 miles per hour, whether on level road or not.

The large easily read scale is held at the correct reading until released by the operator.

For use by Officials, Garages, Service Stations, Manufacturers. You will see these Tapley Meters in use wherever accurate Technical Tests are made, and by those whose success is due to securing the best equipment and the best investment.

Write for Details.

E. C. CHESWELL
Melrose Highlands (77), Mass.

U. S. A. Distributor for Messrs. Tapley & Company, Totton, Southampton, England.

Pacific Coast Distributors: Gillespie Sons, 220 First St., San Francisco, and 929 West 12th St., Los Angeles.

Scientific Instruments since 1819 Kern Aarau

OFTEN YOU NEED
ALWAYS YOU WANT
QUALITY INSTRUMENTS for your work

We offer the following instruments which are used for scientific work in all parts of the globe and which have our full guarantee as to highest quality and performance.

KERN CAMERAS were designed at the suggestion of scientists and have proved their worth in scientific and pictorial work.

KERN PRISM BINOCULARS with their optical correction of the highest quality and their mechanical perfection are chosen by governments and individuals as standards.

KERN OPTICS, such as objectives, lenses, prisms and so on can be furnished for special purposes.

KERN SURVEYING INSTRUMENTS are of modern design, small, precise and rugged and include all groups from Explorers' Transits to Astronomical Universal Instruments.

KERN DRAWING SETS can be replenished in any country in the world. Their precision is lasting.

Detailed information on any of the above Kern lines will be furnished gladly upon request.

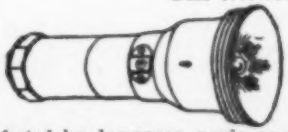
KERN COMPANY 136 Liberty St., New York, N. Y.

Commodore Byrd's Expedition wires for

FIALA SLEEPING BAGS

"Send to me, care expedition Dunedin, NZ, two sleeping suits size 40; two combinations 3 sleeping bags. Shipment Rush."

Scientifically Correct—Warm, Light Weight—Sanitary. Best for outdoor sleeping. Tour and Camp. **$25**
SPECIAL: Light weight 5 lbs.-80" "Llama" Bag and cover; complete **$35**
Mizakel 7X-6 oz. Vest Pocket, Prism Binoculars **$35**
Hensoldt New "Dialyt"—6x30... **$58**
Zeiss Wide-Angle "Deltrentis" —8 x 30 ..... **$66**
Fiala "Miniature" 8 x 24; 10 oz. **$34**
Sports Compass — Luminous Dial **$3.50**



The smallest portable electric light plant in the world. A few turns of the handle, every 3 minutes, makes it run continuously. No batteries; not affected by dampness, needs no adjusting; guaranteed for a year. 8" long. The finest Flash Light made —everyone needs it. **Price, $10 postpaid.**

ANTHONY FIALA, OUTFITS INC.
25 Warren St. *Just off City Hall Park* **New York City**

. . . A niche in the enchanting Palm Court of The Roosevelt, where bright society gathers of afternoons for badinage and tea.

Beauty of appointment, perfection of service, inviting convenience and comfort—these things the management may contribute to a great metropolitan hotel. But it is the guests, themselves, who establish its Atmosphere . . . Cultivated people who make The ROOSEVELT their favored place of residence find here a spirit and a setting which are in perfect accord with their own traditions of good taste.

◇ ◇ ◇

Connected by private passage with Grand Central and the subways . . Complete Travel and Steamship Bureau . . "Teddy Bear Cave," a supervised playroom for children of guests . . Special garage facilities.

BEN BERNIE *and his* ORCHESTRA *in the* GRILL

THE ROOSEVELT

MADISON AVE. at 45th St.
NEW YORK

UNITED HOTELS

EDWARD CLINTON FOGG
Managing Director

Accurate Stopwatches

No. 7096

This stopwatch is calibrated in 1/5 seconds with 30 minute register, start, stop, and fly-back.....$8.00

Genuine Swiss Make

No. 7096C

A high grade 15 jewel timepiece with stopwatch attachment, reading to 1/5 seconds.....$19.90

PALO COMPANY

Apparatus for Industrial and Laboratory Use

153 West 23rd Street, New York, N. Y.

FOR THE

Biological Sciences

Naturalists' Supplies
Microscope Slide Preparations
Preserved Material
Models and Museum Preparations
Lantern Slides
Charts, Botanical and Zoological
Microscopes, Microtomes and Accessories
Dissecting Instruments
Laboratory Glassware
Chemicals
Bacteriological Reagents

Prompt Service — *Guaranteed Quality*

New York Biological Supply Co.

General Supplies for the Biological Sciences
34 UNION SQUARE NEW YORK CITY

BIOLOGICAL SUPPLIES

Zoological
Embryological
Botanical Materials
Drosophila Cultures

Groups
Slides
Life Histories
Philippine Land Shells

A Good Book on Seashore Ecology. Verril's Vineyard Sound Report. $3.00.

Catalogs will be sent on request
Address all correspondence to

Geo. M. Gray, Curator
Supply Department

Marine Biological Laboratory

Woods Hole, Mass., U. S. A.

Complete Equipment for

Explorers, Scientists, Engineers, Hunters and Travelers

We have Equipped many Expeditions From the Poles to the Equator

The only house in the U. S. where every item may be obtained

Gurley's Transits, Levels, Current Meters; Paulin Altimeters; Binoculars, Microscopes, Cameras, Motion Picture Outfits; Tents and Camp Requisites; Sleeping Bags; Saddlery; Outdoor Clothing for every climate; Boats; Arms and Ammunition, etc.

We have recently equipped two expeditions for Greenland, one for Persia and others for Venezuela, Peru, Bolivia, and Brazil. Some of these exploring parties we equipped with practically everything they needed from engineering instruments to rifles, ammunition and food. Our tents, made of Equatorial Waterproof Cloth, have stood the sun of the tropics and the freezing blasts of the Polar regions.

Let us furnish estimates—write us your wants.

Catalogs and Testimonial Letters on request

ANTHONY FIALA 25 WARREN STREET NEW YORK CITY

"Look for the sign of the Polar Bear"

Flowers and Insects

By

CHARLES ROBERTSON

About 225 pp. **$3.00**

"Insects are of the greatest use to man as flower pollinators," says Professor F. Balfour-Browne in his book on insects. "The plants provide pollen and nectar as food and drink for the insects and in return, the insects carry out the pollination, and thus the visits to flowers are of advantage to both parties."

"One might almost imagine that both parties were actually conscious of this, because flowers have undoubtedly become adapted to insects, and insects have become modified in connection with their visits to flowers."

The author of "FLOWERS AND INSECTS" has made a special study extending over many years of insect visits to flowers.

Beginning September, 1887, and ending July, 1899, 7,817 visits to 278 insect flowers were recorded by him. In the present work, these visits are summarized, revised and increased until there are 15,172 visits of 1,288 insects and one humming bird to 441 insect flowers. There are 14 visits to wind flowers and 146 visits to extra-floral nectaries. The 15,172 visits to insect flowers given here are to be compared with 5,231 in Mueller's "Fertilization" and 8,491 in his "Alpenblumen." Mention is made of the types of 232 species of insects and the flowers on which they were taken. The time of blooming of the flowers, the time when the observations were made, the flower class and the color are recorded.

This book is printed and offered for sale by

THE SCIENCE PRESS PRINTING COMPANY

Lime and Green Streets
Lancaster, :: :: Penna.

"A Product of E. LEITZ Precision"

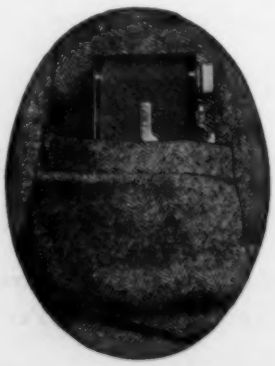
BYRD ANTARCTIC EXPEDITION
RADIOGRAM
RECEIVED BY The New York Times
161WFA LITTLE AMERICA MAR 30
A TRAEGER
PRESIDENT E LEITZ COMPANY 60 E TENTH ST N Y
SEVERAL LEICA CAMERAS INCLUDING MY OWN ON EXPEDITION ALL GIVING EXCELLENT RESULTS SEVERAL PROMINENT EXPEDITION MEMBERS INTERESTED MAY DESIRE SUCH CAMERAS VIA FIRST SUPPLY SHIP IN DECEMBER PLEASE ADVISE BEST TERMS AND DISCOUNTS
SINCERELY
PROF L M GOULD GEOLOGIST
161SP
BYRD ANTARCTIC EXPEDITION
RADIOGRAM
RECEIVED BY The New York Times
161WFA LITTLE AMERICA MAR 30
A TRAEGER
PRESIDENT E LEITZ CO
60 E 10TH ST NEW YORK CITY
MY BROTHER OF EXPLORERS CLUB MAY BE INTERESTED YOUR POCKET CAMERA FOR AVIATION WORK IN YUKON AND NORTHERN CANADA HAVE RECOMMENDED LEICA IN VIEW EXCELLENT RESULTS HERE AND AM CONSIDERING PURCHASE OF ONE FOR MYSELF PLEASE ADVISE YOUR BEST TERMS
161SP
LIEUT M P HANSON

The excellent work of the *Leica* Camera evidenced in these messages from members of the Byrd Expedition

You may never have occasion to use your camera in the arctic or torrid regions, but the same mechanical and optical precision that guarantees *Leica's* unfailing service under the most difficult conditions assures you of finer pictures everywhere —every time. There are no *special* *Leica* Cameras. Those accompanying the Byrd Expedition are but duplicates of the *Leica* Camera sold by leading photo supply dealers.

The smallest roll film camera with a Focal-Plane shutter. Exposures of 1/20 to 1/500 sec. Equipped with the famous Elmar Anastigmat F 3.5, 50 mm. lens.

Thirty-six pictures on a single load of standard Cinema film. Enlargements to 12″ x 18″ or more. Screen projection.



Leading photo supply dealers will gladly demonstrate the *Leica*, or write for details and examples.

Write for Pamphlet No. 1127 (FF)

E. LEITZ, Inc.

60 East 10th St.

NEW YORK, N. Y.

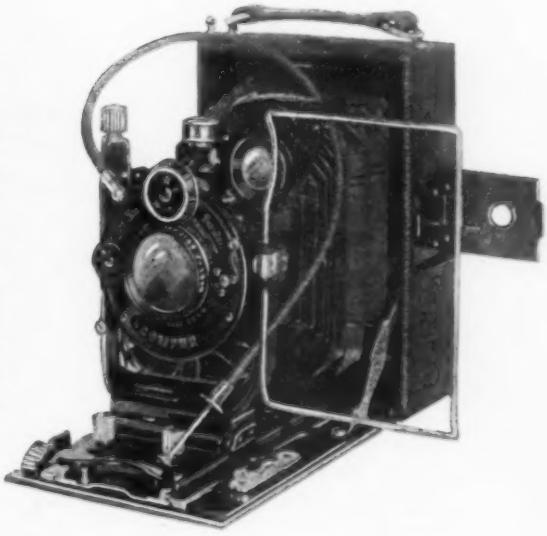
Agents for the Pacific Coast:
SPINDLER & SAUPPE
86 Third Street
San Francisco, Calif.
811 W. 7th Street
Los Angeles, Calif.

ZEISS

OPTICAL INSTRUMENTS

ZEISS Prism Binoculars, in addition to their brilliant luminosity and large field of view, are dust- and moisture-proof, a factor which can hardly be over-emphasized. With supplementary lens attachments they are instantly convertible into Telescopic Magnifiers, having a working distance of about 8 inches.

Zeiss Ikon Cameras, fitted with Zeiss Tessar Lenses, take excellent pictures, even under conditions, where other cameras fail. Zeiss Tessar Lenses and Compur Shutters are standard equipment on all, except the Junior Cameras. All models, having double bellows extension, may be used with the Zeiss Proxar and Distar supplementary Lenses.



Catalogues will be sent on request

CARL ZEISS, INC.

485 Fifth Avenue
NEW YORK

728 So. Hill Street
LOS ANGELES

CARL ZEISS
JENA

LaMOTTE–MORGAN SOIL TESTING SET

This handy outfit is based on the indicator method and is designed for accurate, rapid work in determining soil reactions. Can be used on soils of any texture and any moisture content, except very wet clay soils. Tests can be made in from two to five minutes and results are accurate to 0.2 pH. Invaluable to agricultural schools, experiment stations, florists, nurserymen, and all interested in the study of plants and soils.

Each set includes complete instructions, color chart, and La-Motte Soil Handbook containing an extensive list of plants with their soil preferences.

Price $10.00 f.o.b. Baltimore

LaMotte

LaMotte Chemical Products Co., 422 Light St., Baltimore, Md., U.S.A.

Laboratory Apparatus and Supplies

PARIS EXPOSITION: Eight Awards and Medals

PAN-AMERICAN EXPOSITION: Gold Medal

Our General Laboratory and Museum Supplies Include:

Scientific Apparatus and Instruments, Chemicals, Anatomical Models, Osteological Preparations, Natural History Specimens and Preparations, Wall Charts, Museum and Naturalists' Supplies, Glass Jars, Microscopes and Accessories.

Museum Cabinets (Yale Style) **Biological and General Laboratory Supplies**

THE KNY-SCHEERER CORPORATION OF AMERICA

Dept. of Natural Science, G. Lagai, Ph.D.

10–14 West 25th Street New York City